X-Y PLOTTER

MP2300

MANUAL NO. MP2300-UM-151H

USER'S MANUAL

WESTERN GRAPHTEC

WESTERN GRAPHTEC, INC.

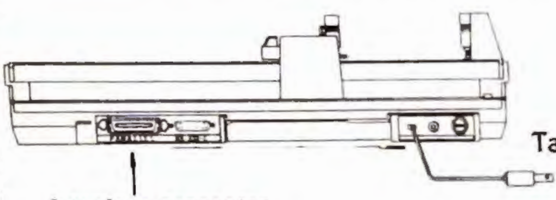
- Plotter's switch setting

The interface setting on the plotter is done by setting the DIP switches S2 on the plotter's base, as shown in Fig. 5-2-3.

Table 5-2-3 shows the data transmission conditions specified by the setting of Fig. 5-2-3.

The example shows the setting for standard data transmission conditions. Settings for other transmission conditions are also possible, but make sure that the computer is also set for the same conditions.

Turn the plotter's power off before setting these switches.



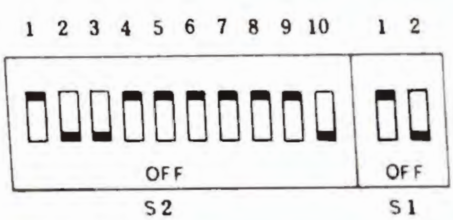


Table 5-2-3 Data transmission conditions

Baud rate	:	2400 baud
Character length	:	8bits
Parity	:	EVEN
Stop bit	:	2bits

(Plotter is shipped from the factory with this setting.)

COMMAND MODE : FP

Fig. 5-2-3 RS-232-C interface switch setting

- Switch setting on computer side

The method of setting the data transmission conditions depends on the computer used. This is explained below together with program examples.

- Connection to computer

Before connecting the plotter to the computer, confirm that the plotter is switched off.

Use the specified cable (see Table 5-2-2) for the connection to the computer. Plug the connector with the CPU seal into the computer's RS-232-C port and the connector with the PLOTTER seal into the plotter.

- Confirming the connection

To confirm the connection, operate the plotter by sending data from the computer. The examples given below are in BASIC, which is the usual language for personal computers. Refer to these examples and check the plotter's operation, using the method most suitable for your computer.

Check the operation in the following way. When the program shown below is keyed in and run, the plotter draws a circle of a radius of 50 mm, with the character string ABC .... XYZ inside it, then returns the pen to the HOME position. (See Fig. 5-2-2.)

- Operation of computer and program listing

1) Example using NEC PC-9801/E/F, PC8801/mk II

- Connection method

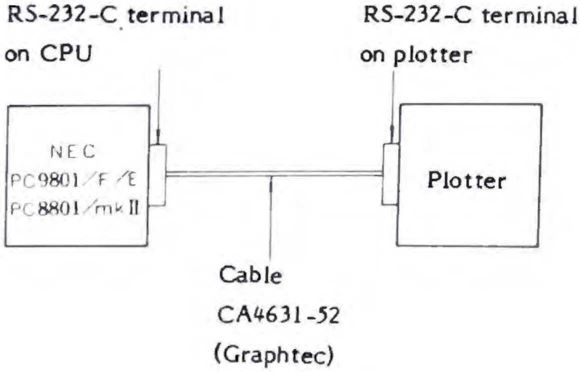
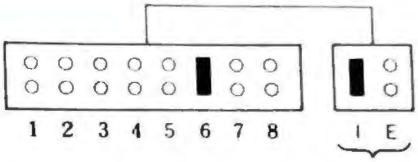


Fig. 5-2-4 Connection to computer

- The PC8801/mk II is set by the jumper switches on its rear panel and an OPEN statement in the program.

Jumper switches



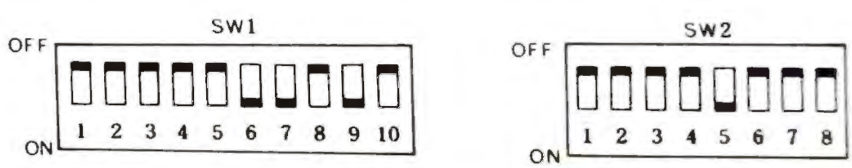
OPEN statement

```
OPEN"COM:E83"AS #1
```

These switches are not provided in the PC8801 mk II, so there is no need to set them.

Fig. 5-2-5 Setting of jumper switches in PC8801/mkII

- The PC9801/E/F is set by the DIP switches on its rear panel and an OPEN statement in the memory switch program. (The OPEN statement is the same as that for the PC8801/mk II.)



(Bit 1 of SW1 is set for standard display. For special high-resolution display, set it to ON.)

Fig. 5-2-6 Setting of DIP switches in PC9801/E/F

- Setting the PC9801 memory switch

Set by keying in the following from the keyboard of the PC9801:

PC9801's memory switch setting

```
OK
mon [RETURN]
n] ssw2 [RETURN]
xx-06 [RETURN]
n] ↑B
```

* ↑ B means the CTRL key is pressed together with B.

- Program listing

Program example for PC9800/F/E:

```
10 REM * SAMPLE 5-2-3 *
20 OPEN"COM:E83" AS#1
30 PRINT#1,"W1000,1000,500,500,0,3600";CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT#1,"M";X;Y;"P";C$;CHR$(3)
60 PRINT#1,"H"
70 END
```

2) Example using IBM PC XT/AT/JX/5550:

- Connection method

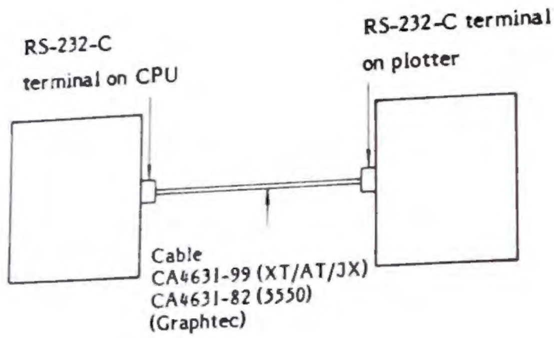


Fig. 5-2-7 Connection to computer

- The data transmission conditions are set by the OPEN statement in the program for the IBM PC.

OPEN statement

```
OPEN " COM1 : 2400,E,7,1,RS,CS,DS,CD " AS #1
```

- Change the plotter's switch setting to that shown in Fig. 5-2-8.

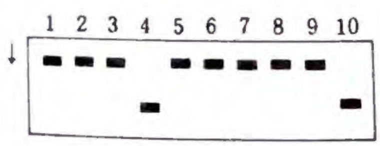


Fig. 5-2-8

- Program listing

```
10 REM * SAMPLE 5-2-4 *
20 OPEN "COM1:2400,E,7,2,RS,CS,DS,CD" AS #1
30 ON COM(1) GOSUB 65000
40 COM(1) ON
50 PRINT#1,"W1000,1000,500,500,0,3600"+CHR$(3)
60 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
70 PRINT#1,"M";X;Y;"P"+C$+CHR$(3)
80 PRINT#1,"H"
90 END
65000 REM X-ON/X-OFF CONTROL SUBROUTINE
65010 IF LOC(1)=0 THEN RETURN
65020 XIN$=INPUT$(1,#1)
65030 IF XIN$=CHR$(19) THEN 65020
65040 RETURN
```

- Explanation of program

30 40	Permits a break for Xon/off
65000 65040	A subroutine for Xon/off handshaking

4) Example using Fujitsu FM-7/New7, FM-8, FM-77 or FM-11:

- Connection method

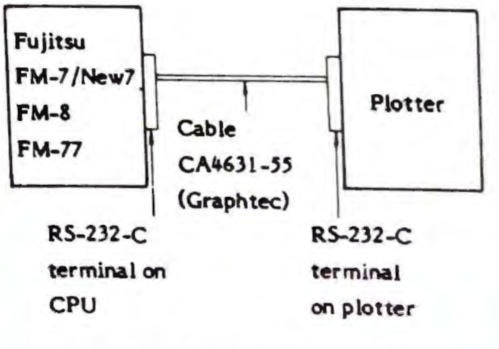


Fig. 5-2-9 Connection to FM-7, 8

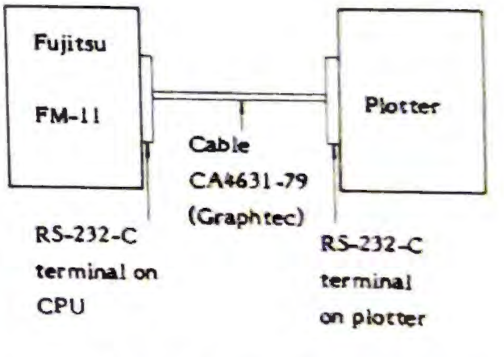


Fig. 5-2-10 Connection to FM-11

- Program listing

Program example for PC9800/F/E:

```
10 REM * SAMPLE 5-2-3 *
20 OPEN"COM:E83" AS#1
30 PRINT#1,"W1000,1000,500,500,0,3600";CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT#1,"M";X;Y;"P";C$;CHR$(3)
60 PRINT#1,"H"
70 END
```

2) Example using IBM PC XT/AT/JX/5550:

- Connection method

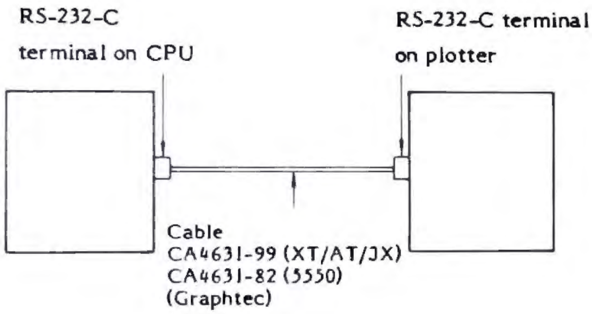


Fig. 5-2-7 Connection to computer

- The data transmission conditions are set by the OPEN statement in the program for the IBM PC.

OPEN statement

```
OPEN " COM1 : 2400,E,7,1,RS,CS,DS,CD " AS #1
```

- Change the plotter's switch setting to that shown in Fig. 5-2-8.

Fig. 5-2-8

- <u>Program listing</u>

```
10 REM * SAMPLE 5-2-4 *
20 OPEN "COM1:2400,E,7,2,RS,CS,DS,CD" AS #1
30 ON COM(1) GOSUB 65000
40 COM(1) ON
50 PRINT#1,"W1000,1000,500,500,0,3600"+CHR$(3)
60 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
70 PRINT#1,"M";X;Y;"P"+C$+CHR$(3)
80 PRINT#1,"H"
90 END
65000 REM X-ON/X-OFF CONTROL SUBROUTINE
65010 IF LOC(1)=0 THEN RETURN
65020 XIN$=INPUT$(1,#1)
65030 IF XIN$=CHR$(19) THEN 65020
65040 RETURN
```

- Explanation of program

30 40	Permits a break for Xon/off
65000 65040	A subroutine for Xon/off handshaking

4) Example using Fujitsu FM-7/New7, FM-8, FM-77 or FM-11:

- <u>Connection method</u>

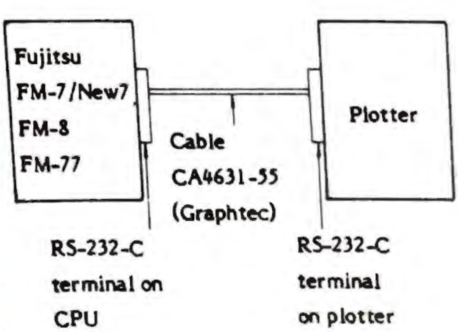


Fig. 5-2-9 Connection to FM-7, 8

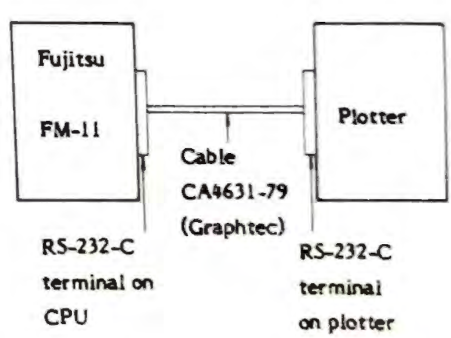


Fig. 5-2-10 Connection to FM-11

- Set the DIP switches on the rear panel of the FM-8 as shown in Fig. 5-2-11.

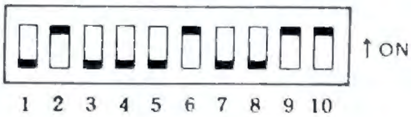


Fig. 5-2-11

- Set the DIP switches on the rear panel of the FM-11 as shown in Fig. 5-2-13.

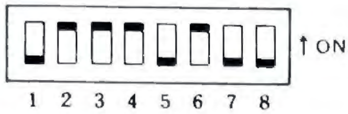


Fig. 5-2-13

- Set the DIP switches on the FM-7/New 7 or FM-77's interface card (MB22406) as shown in Fig. 5-2-12.

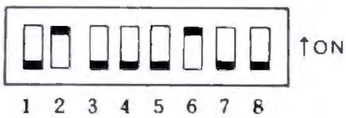


Fig. 5-2-12

- <u>Program listing (F-BASIC)</u>

Example of program for FM-7/New 7, FM8, FM77 or FM11:

```
10 REM * SAMPLE 5-2-5 *
20 OPEN"O",#1,"COM0:(F8E2)"
30 PRINT#1,"W1000,1000,500,500,0,3600";CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT#1,"M";X;Y;"P";C$;CHR$(3)
60 PRINT#1,"H"
70 END
```

* If using the FM-16β, insert 25 BAUD 0, 2400 as line 25.

5) Example using OKI IF800 MODEL 20/30/50:

- <u>Connection method</u>

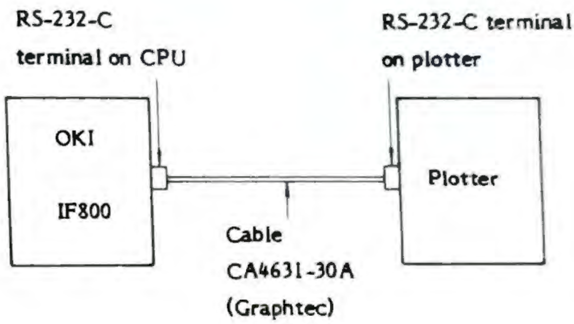


Fig. 5-2-14 Connection to IF800

- There is no need to set the DIP switches of the IF800.

- <u>Program listing</u>

  Example of program for IF800

```
10 REM * SAMPLE 5-2-6 *
20 OPEN "COM1:6E83" AS #1
30 PRINT#1,"W1000,1000,500,500,0,3600";CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT#1,"M";X;Y;"P";C$;CHR$(3)
60 PRINT#1,"H"
70 END
```

5-2-3 Connection using GP-IB interface

The GP-IB interface is used for measuring systems; it conforms to the IEEE-488 standards.

This interface enables the connection of various pieces of equipment to the same bus line which is standardized, so that the addition of a printer or plotter to such a system is easy.

However, note that this interface has address-setting switches for selecting the equipment.

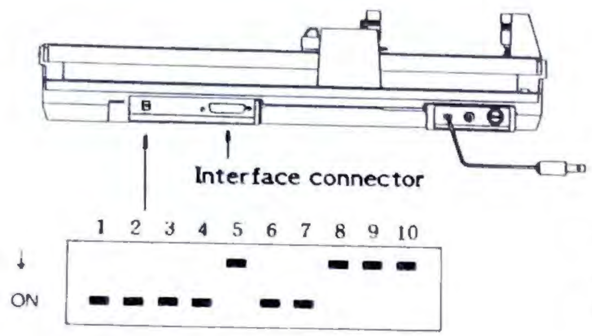
For connection to the computer, use the connection cable given in the table below which lists representative computers.

Following the list are some examples of connections to different computers.

Table 5-2-3 Connection cables for GP-IB interface

Computer name	Manufacturer	Cable name	Remarks
PC-8801/mk II	NEC	CA4631-32	GP-IB board PC-8897 necessary on computer side.
PC-9801 PC-9801E/F	NEC	Not necessary	GP-IB board PC-9801-06 or PC-9801-19 necessary on computer side.
SEIKO 9100 9500	SEIKO	CA4631-32	GP-IB option necessary on computer side.
HP-83, 85	HP	Not necessary	HP-IB card (82937A) and I/O control ROM necessary on computer side. Cable is provided with HP-IB card.
HP-9825 9835 9845	HP	Not necessary	HP-IB card (98034A) and I/O control ROM necessary on computer side. Cable is provided with HP-IB card.
MZ-80B MZ-2000 MZ-2200	Sharp	CA4631-34	GP-IB card (MZ-8BIO4) and, SB-6521 DISK BASIC necessary on computer side.
C-280	PANAFACOM	Not necessary	Standard interface adaptor necessary on computer side.

- Plotter's switch setting



ADRESSABLE
ADDRESS No: 1
EOI is invalid

Fig. 5-2-14 Switch setting of GP-IB interface

Set the plotter's interface by setting the DIP switches on the side of the interface connector on the rear panel, as shown in Fig. 5-2-14.

The example shows the standard address setting, but other address settings are also possible.

Note that the computer must also be set to the same address.

Turn the plotter off before setting these switches.

- Switch setting on computer side

The method used to set the data transmission conditions on the computer differs according to the computer used. Different methods are given below, together with program examples.

- Connection to computer

Before connecting the plotter to the computer, confirm that the plotter is turned off. For the connection to the computer, use the specified cable (Table 5-2-3) and connect it to the GP-IB interface terminal of the computer.

· Confirming the connection

To confirm the connection, operate the plotter with data from the computer.

The examples given here are in BASIC, since it is the usual language for personal computers. Refer to these examples to check the operation of the plotter, using the method most suitable for your computer.

Check the operation in the following way. When the program given below is keyed in and run, the plotter will draw a circle of a radius of 50 mm, with the character string ABC ....XYZ inside it, then return to the HOME position. (See Fig. 5-2-2.)

· Operation of computer and program listing

1) Example using NEC PC-9801/E/F:

· Connection method

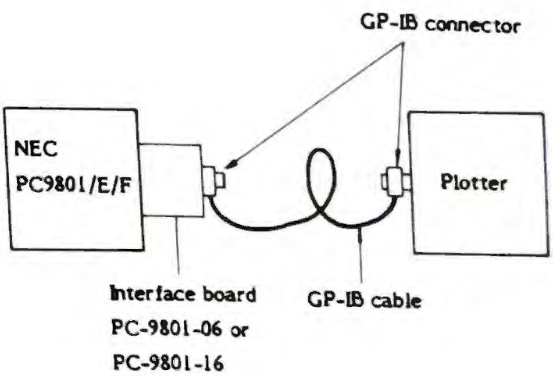
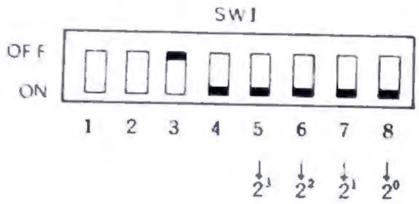


Fig. 5-2-15 Connection to PC9801

- Switch setting on PC-9801/E/F

(1) Setting of DIP switches on GP-IB board



Set the GP-IB address by SW1-5 to SW1-8.

The setting in Fig. 5-2-16 gives the address 0.

Fig. 5-2-16

(2) Set the DIP switches on the rear panel of the PC9801, as shown in Fig. 5-2-17.

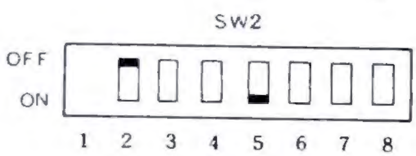


Fig. 5-2-17

(3) Setting of the PC9801 memory switch

```
OK
mon [RETURN]
h] ssw4 [RETURN]
   xx-20 [RETURN]
h] ↑B
```

↑B means the CTRL key is pressed together with B.

- Program listing

```
10 REM * SAMPLE 5-2-7 *
20 ISET IFC
30 PRINT@1;"W1000,1000,500,500,0,3600"+CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT@1;"M",X,Y,"P"+C$+CHR$(3)
60 PRINT@1;"H"
70 END
```

2) Example using the Hewlett Packard HP-85:

- Connection method

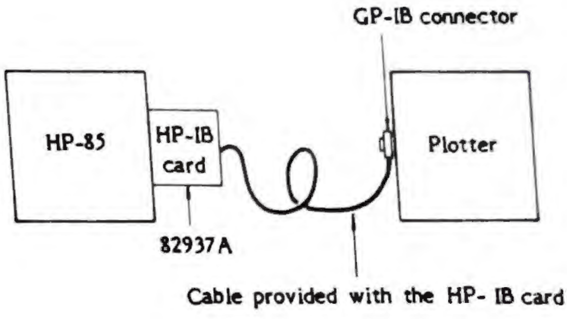


Fig. 5-2-18 Connection to HP-85

- No switch setting is needed on the HP-85.

  Operate the plotter with the following program.

- Program listing

```
10 REM * SAMPLE 5-2-8 *
30 OUTPUT701"W1000,1000,500,500,0,3600";CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 OUTPUT701"M";X;Y;"P";C$;CHR$(3)
60 OUTPUT701"H"
70 END
```

6. PROGRAM EXAMPLES

The MP2300 can draw diagrams very easily, according to data sent from a computer.

Examples of programs which provide basic plotting, using standard BASIC, are given below. The program examples use the data output statement LPRINT for a Centronics interface. If you are using another interface, or a computer which cannot output LPRINT (FM-8, IF800, etc.), modify the programs partially, referring to Section 5-2. See Section 7 for descriptions of all the commands and parameters, as well as how to combine them in the program examples. Personal-mode commands are used in these examples, so set the DIP switches S1 on the plotter's base as shown in Fig. 6-1-1.

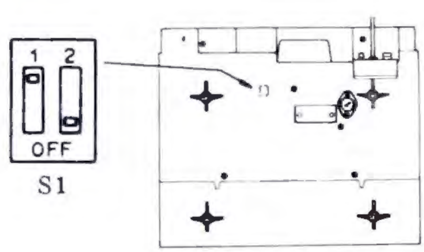


Fig. 6-1-1 Setting of DIP switches on plotter's base

CONTENTS

1. OUTLINE

1-1 Outline of MP2300

The MP2300 was developed from the technology and experience that Graphtec has accumulated over its many years of X-Y plotter production.

The latest technology adopted in the MP2300 enables it to provide the highest levels of quality, functions, and performance, making it suitable for a wide range of applications including graphs, statistical charts, designing, engineering (Computer Aided Design), NC tape check monitors, computer art, and also hobbies.

1-2 Features

* Automatic pen-capping mechanism

The pen station is equipped with pen caps to prevent the ink drying up. The pens are automatically capped when not being used, so that they are always kept in the best condition for plotting.

* High plotting speed

Each pen draws at a speed of 25 cm/s, the highest speed in a plotter of this class. When raised, the pen moves at 40 cm/s, providing high-speed plotting the equal of a more expensive plotter's.

* Sophisticated plotting commands

The MP2300 has three switch-selectable, built-in command sets - Graphtec's own DIGIPLOT (MP1000) and PERSONAL PLOTTER (FP5301 with 9 additional commands) sets, and an HP-GL™ emulation command set for easier program creation. These sophisticated functions include the drawing of circles and curves, enlargement and reduction, rotation of plot, hatching of polygons, and read-out of coordinates.

o HP-GL is a trademark of Hewlett-Packard

* Easy-to-see, clear character patterns

Clear character patterns featuring curved lines have been adopted to provide neat plotting. Character fonts are provided for various different countries: Japan, U. S. A., Britain, Germany, France, Sweden, Denmark, Spain, etc.

* Data buffer

A 6 Kbyte memory is provided as data buffer.

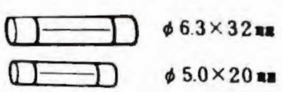
* Drawing pens

Five types of pen can be used: water or oil based fiber-tip pens, water based ball-point pens, ceramic pens, and ink pens.

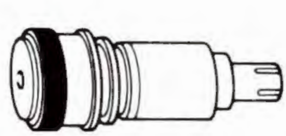
2. CHECKING THE ACCESSORIES

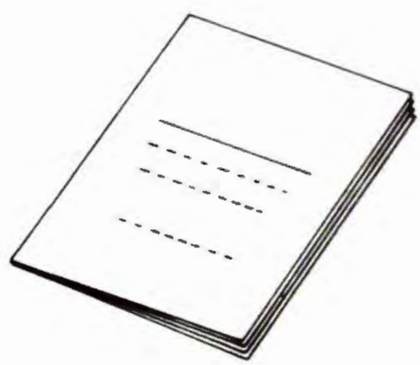
2-1 Standard accessories

(1)	Fuse:	For 100 V series:	1
		For 200 V series:	2
(2)	Fiber-tip pens (water based) KF550, black, red, blue, green, brown, violet, orange, and pink:		1 each
	Fiber-tip pens (oil based) KF560, 2 black, 1 each of red, blue, and green		
(3)	Paper PL501 (A3 size, 50 sheets):		1 pack
(4)	Fuse cap:		2
(5)	User's manual:		1 copy
(6)	Plastic cover:		1



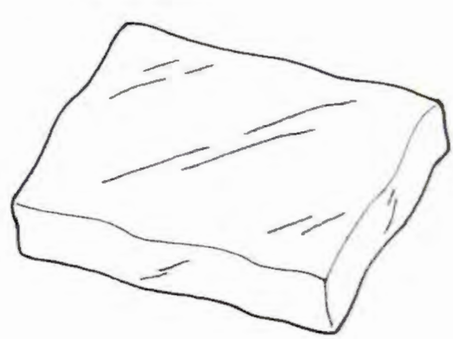
(2) Pen





(3) Paper

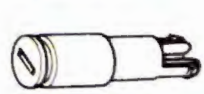
(6) Plastic cover



(4) Fuse cap

For 100V series
gray

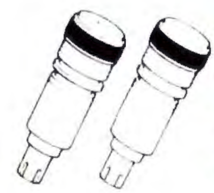
For 200V series
black

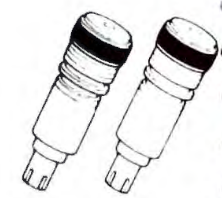


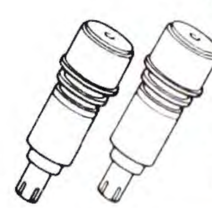
2-2 Supplies

2-2-1 Pens and pen parts

Item	Part number	Contents
Fiber-tip pen (Water based)	KF551-RD	5 pens, red
	KF552-BK	5 pens, black
	KF553-VT	5 pens, violet
	KF554-BR	5 pens, brown
	KF555-BL	5 pens, blue
	KF556-GR	5 pens, green
	KF557-OR	5 pens, orange
	KF558-PK	5 pens, pink
	KF550-S1	2 black, 1 each of red, blue, and green
	KF559-S2	1 each of black, violet, brown, orange, and pink
Fiber-tip pen (Oil based)	KF561-RD	5 pens, red
	KF562-BK	5 pens, black
	KF565-BL	5 pens, blue
	KF566-GR	5 pens, green
	KF560-S1	2 black, 1 each of red, blue, and green
Ball-point pen (Water based)	KB541-RD	5 pens, red
	KB542-BK	5 pens, black
	KB545-BL	5 pens, blue
	KB546-GR	5 pens, green
	KB540-S1	2 black, 1 each of red, blue, and green
Ceramic pen	KC-503	0.3 ϕ
	KC-505	0.5 ϕ
	KC-507	0.7 ϕ







Item	Part number	Contents
Ink pen plunger	PHP30-INK	2
Pen nib (for ink pen)	KD112	0.2 ϕ
	KD113	0.3 ϕ
	KD114	0.4 ϕ
	KD115	0.5 ϕ
	KD116	0.6 ϕ
	KD118	0.8 ϕ

2-2-2 Papers

Item	Part number	Contents
Paper	PL501	Glossy blank paper, 50 sheets
	SP325	Measurement paper, 50 sheets
	PL507	Tracing paper, 50 sheets
	PL508	OHP film, 20 sheets

3. NOTES ON USE

3-1 Notes on installation and operation

- Do not use or store the MP2300 where it will be exposed to direct sunshine or the draft from an air conditioner or heater.

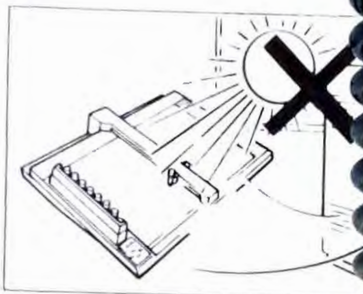


Fig. 3-1-1

- Do not use the MP2300 where there is a lot of dust or a high humidity.

- Do not place your hands or any heavy object on the writing panel.

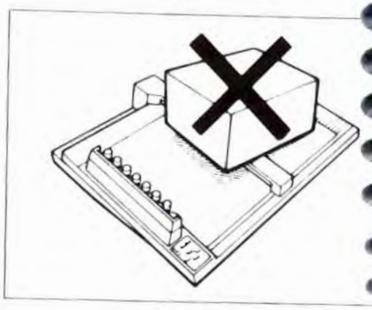


Fig. 3-1-2

- Do not push strongly or bend the Y-slider or shaft.

- Do not use the MP2300 in places subject to mechanical vibration or electrical noise.

- When not using the MP2300, cover it with the plastic cover or a cloth to protect it from dust.

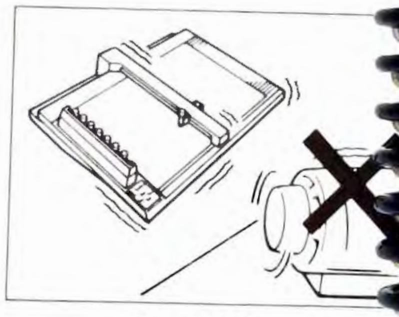


Fig. 3-1-3

- Magnets are used in the pen station and pen carriage of the MP2300. Do not put any magnetic card, magnetic tape, diskette, etc., near the pen station or pen holder units.

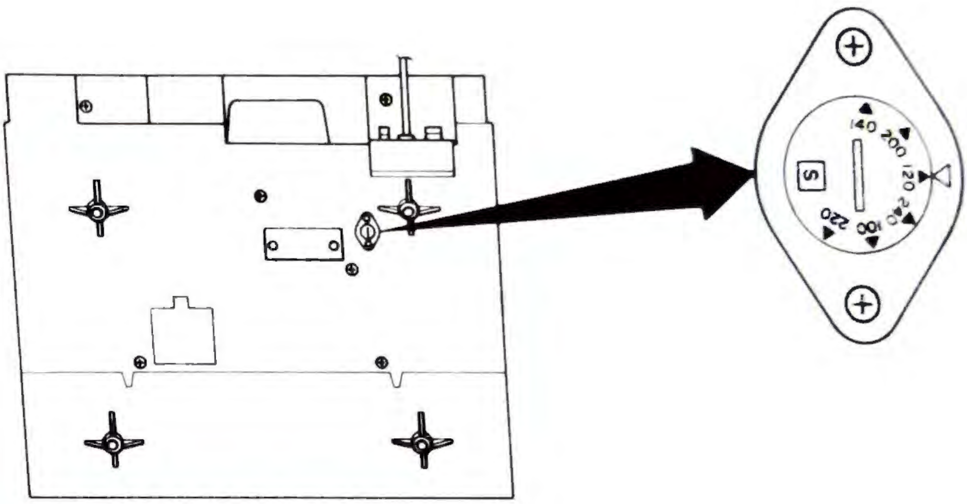
- Use only the specified power voltage. Never use a power supply other than that specified.

- Never oil the mechanical units since this may cause malfunctions.

3-2 Changing the voltage (selector)

(1) Make sure that the power switch is off, and that the power cable has been disconnected from the outlet.

(2) Grip the carrying handle at the top and turn the plotter over so that it is resting on its face. There is a voltage selector on the bottom plate of the plotter as shown in the diagram below.



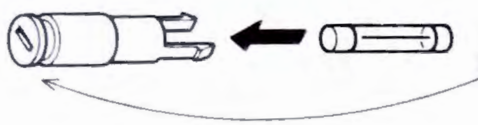
(3) Insert a coin or similar to turn the selector to the required setting.

Note 1: If you are changing from the 100V series to the 200V series or vice versa, the fuse must also be changed. The fuses can be differentiated by the color of the caps.

100V/120V fuse

Color of fuse cap: gray

ϕ6.3 x 32mm
250V 1A

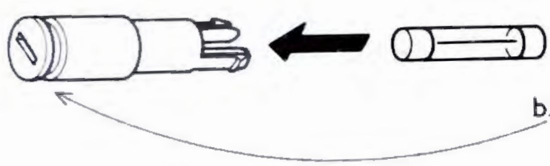


gray

200/220/240V fuse

Color of fuse cap: black

ϕ5 x 20mm
250V 0.5A



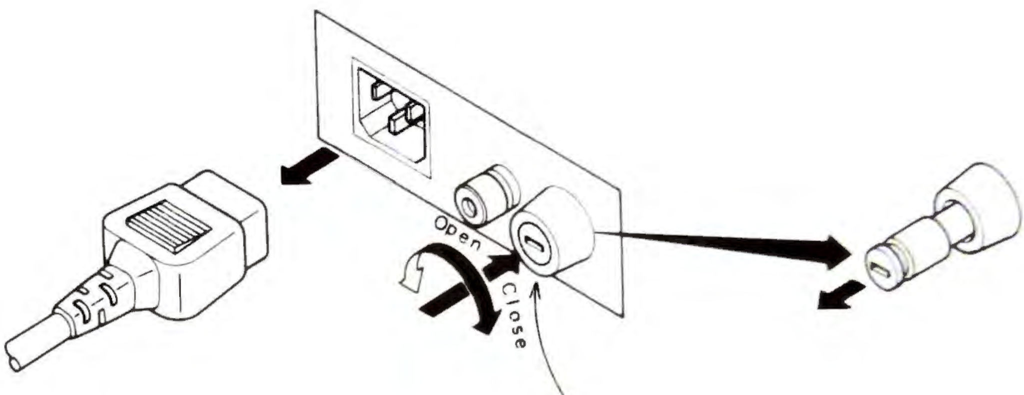
black

Note 2: If the voltage is 117V, set the selector to 120V, and if it is 110V, set the selector to either 100V or 120V. Please ignore the 140V setting - it is not available.

3-3 Changing the fuse

(1) Make sure that the power cable has been removed from the connector next to the fuse.

Remove the power cable



Push in and turn   Fuse holder

(2) Unfasten the screw at the center of the fuse holder with a pushing and turning motion. This will release the spring, and the fuse cap will protrude from the holder. Remove the fuse.

(3) Insert the correct fuse into its cap (gray for 100V series and black for 200V series), and then place it into the holder. Screw back into place using the pushing and turning motion used to unfasten the screw.

(4) Reconfirm the color of the fuse cap and that the voltage is correct before reinserting the power cable into the connector and turning the power on.

3-4 Loading the paper

Insert the paper from the right side of the writing panel, as shown in Fig. 3-4-1

Line up the left and top edges of the paper against the borders of the writing panel, and then turn the power on. Press the CHART HOLD switch and firmly smooth the paper so that there are no wrinkles and no air is trapped between the paper and the panel.

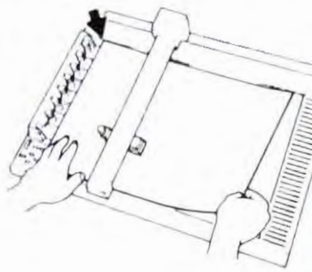


Fig. 3-4-1

3-5 Attachment of pens

Use the pens provided with the plotter for plotting.

To attach a pen, insert the lower groove of the pen into the notch in the pen station, as shown in Fig. 3-5-1

The pens are numbered from 1 to 8, starting from the front of the pen station.

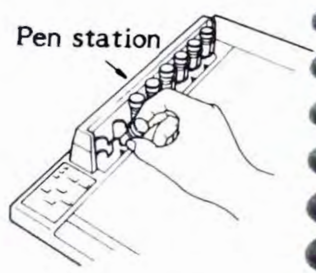


Fig. 3-5-1

3-4 Loading the paper

Insert the paper from the right side of the writing panel, as shown in Fig. 3-4-1

Line up the left and top edges of the paper against the borders of the writing panel, and then turn the power on. Press the CHART HOLD switch and firmly smooth the paper so that there are no wrinkles and no air is trapped between the paper and the panel.

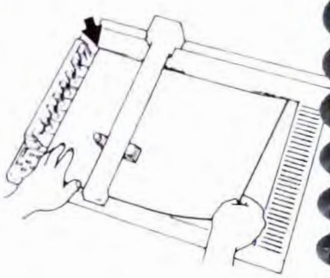


Fig. 3-4-1

3-5 Attachment of pens

Use the pens provided with the plotter for plotting.

To attach a pen, insert the lower groove of the pen into the notch in the pen station, as shown in Fig. 3-5-1

The pens are numbered from 1 to 8, starting from the front of the pen station.

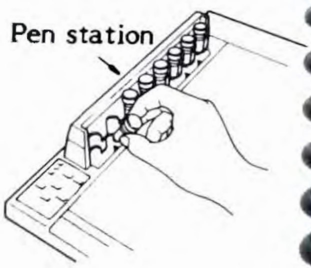


Fig. 3-5-1

Note	Incorrect or loose attachment of pens will result in malfunctions and other problems.

Note	Before turning the power on, remove the pen attached to the pen carriage, if any, and insert it into the corresponding pen station notch. Then turn the power on.

Pens are attached to and removed from the pen station.

Fig. 3-5-2 shows how the lower groove of the pen is inserted into the notch of the pen station. Check that the cap is pushed downwards and the pen tip is inserted completely into the pen cap.

(1) Correct attachment

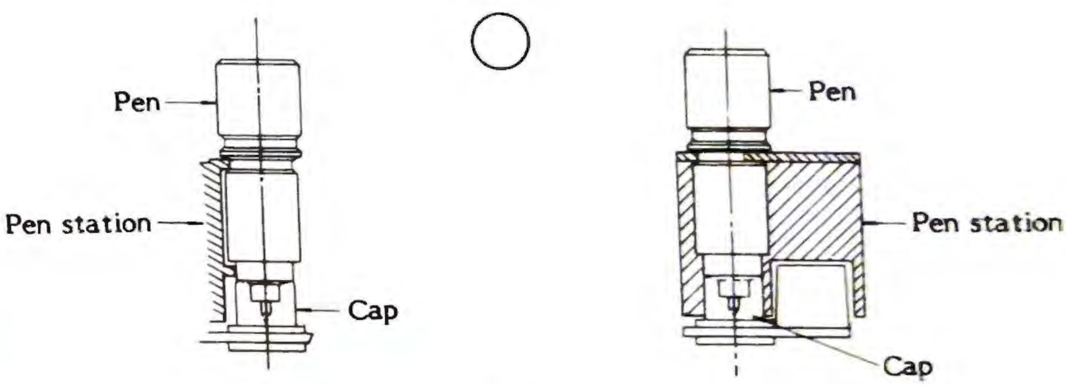


Fig. 3-5-2

(2) Incorrect attachment

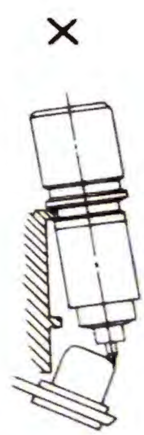


Fig. 3-5-3

If there is too much space between the notch in the pen station and the pen, or if the pen tip is not completely inserted into the cap, as shown in Fig. 3-5-3, malfunctions or other problems may occur.

To remove a pen, pull it to the left and forward, following the direction of the notch.

3-6 Pen types and assembly (fiber-tip pen, ink pen)

o Fiber-tip pen (water based)

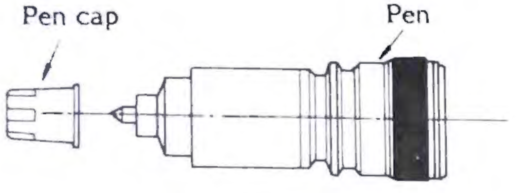


Fig. 3-6-1 Fiber-tip pen

Put the caps back on water based fiber-tip pens when not using them.

o Ink pen

The pen nibs of the ink pens can be replaced, as shown in Fig. 3-6-2

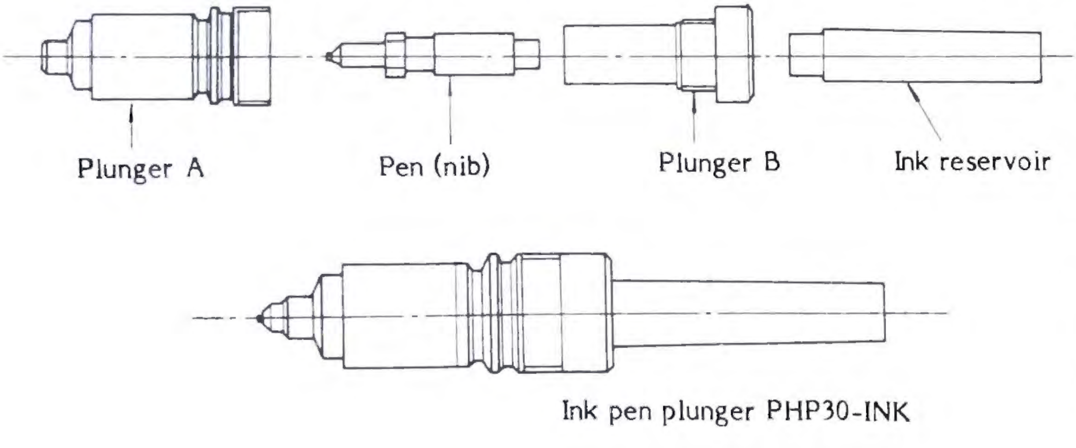


Fig. 3-6-2 Ink pen

How to assemble a pen (1) - (3)

(1) Screw the pen (nib) into the pen plunger B until it reaches the end. (The case of the pen nib can be used as a tool for screwing it into the plunger.)

(2) Fill the ink reservoir with ink and insert it into plunger B. The ink will not have reached the nib yet, so hold the pen vertically and shake it gently up and down until the ink starts to flow through the nib when the pen is drawn across a piece of paper. Do not shake the pen too strongly or ink may flow from the hole on the side of the pen nib and spoil the quality of the drawing.

(3) Finally screw plunger B with the pen nib and ink reservoir into plunger A until it is fixed.

Note: Always disassemble the ink pen after use, wash it in water, and wipe it with a dry cloth before storing it. If the pen is left with the reservoir full, the ink may settle and cause problems such as blockage of the nib or overflowing of the ink.

3-7 Pens and papers

Several kinds of pen and paper are available for use with the MP2300 Select the most suitable combination of pen and paper according to your plotting requirements.

a) Types of pen

Ball-point pen (water based) KB540 series
4 colors (black, red, blue, and green) 5 pens/pack

Fiber-tip pen (oil based) KF560 series
4 colors (black, red, blue, and green) 5 pens/pack

Fiber-tip pen (water based) KF550 series

8 colors (black, red, blue, green, violet, brown, orange, and pink) 5 pens/pack

Ink pen (nib) KD112 (0.2 ϕ) - KD118 (0.8 ϕ)

0.2 ϕ - 0.8 ϕ

Ink HD101 - 106 (black, red, blue, and green, 20 cc each)

Ceramic pen

0.3 ϕ	KC-503
0.5 ϕ	KC-505
0.7 ϕ	KC-507

B) Types of paper

Leaf paper

SP325 (measurement paper, 300 mm x 420 mm, 50 sheets/pack)

PL501 (glossy blank paper, 300 mm x 420 mm, 50 sheets/pack)

PL507 (tracing paper, 300 mm x 420 mm, 50 sheets/pack)

PL508 (transparent film, 260 mm x 260 mm, 20 sheets/pack)

C) Pen characteristics

(1) Ball-point pen (water based)

- Suitable for plotting at relatively high speeds.
- The line width is about 0.2 mm - 0.3 mm.
- The ink flow is not smooth at very low plotting speeds.
- Maximum line length is about 1,000 meters.

(2) Fiber-tip pen (oil based)

- Use for plotting on OHP film.
- The line width is thick: 0.4 mm to 0.7 mm.
  (Use the specified recording film, otherwise the spreading of ink may widen the lines.)

- A low plotting speed is necessary (20 cm/s or less).
- The ink used is volatile, although it dries up more slowly than ordinary volatile inks, so careful handling is necessary. Cap the pen and store it in a plastic bag after use.
- Maximum line length is about 400 meters.

(3) Fiber-tip pen (water based)

- 8 colors are available.
- The line width is 0.3 mm to 0.7 mm.
- Easier to use than other pens.
- Maximum line length is about 1,000 meters.

(4) Ceramic pen

- Line width can be selected (3 nib types: 0.3 ϕ, 0.5 ϕ and 0.7 ϕ).
- Suitable for drafting.
- Easier to handle than an ink pen.
- Maximum line length is about 1,000 meters for a 0.3 ϕ or 0.5 ϕ pen, and 600 meters for a 0.7 ϕ pen.
- A very low plotting speed is necessary (10 cm/s or less).

(5) Ink pen

- Line width can be selected (6 nib widths from 0.2 ϕ to 0.8 ϕ.)
- Suitable for drawing diagrams.
- Requires more care in handling, washing, and storage than other pens. (Particularly the 0.2 ϕ pen.)
- A very low plotting speed is necessary (10 cm/s or less).

D) Characteristics of papers

(1) Measurement paper
(leaf paper SP325)

- Expansion and contraction of paper due to humidity changes are small.
- Little smudging of ink.
- Wet copying is possible to some extent.
- The adhesion of ink is relatively weak at high plotting speeds.

(2) Glossy blank paper
(leaf paper PL501)

- The adhesion of ink is good because the surface is smooth.
- Clear drawings since the paper is extremely white.
- Expansion and contraction due to humidity changes are larger than those of the measurement paper.
- Not suitable for ink pens since it takes time for the ink to soak into the paper.

(3) Tracing paper
(leaf paper PL507)

- Drawings can be wet-copied.
- Expansion and contraction due to humidity changes are large.
- Not suitable for pens other than ink pens and ceramic pens.

(4) Transparent film
(leaf paper PL508)

- Use for OHP drawing.
- Only fiber-tip pens (oil based) can be used.

Table 3-7-1 Suitability of pens for each type of paper
(Use this table for reference)

<table>
<tr><th>Type of paper / Type of pen</th><th>Coated paper PL501</th><th>Measurement paper SP325</th><th>Tracing paper PL507</th><th>Film PL508</th><th>Max. plotting speed (cm/s)</th><th>Line width (mm)</th><th>Main usage</th><th>Characteristics</th></tr>
<tr><td>Ball-point pen (water based)</td><td>◎</td><td>○</td><td>○</td><td>×</td><td>25</td><td>0.2~0.3</td><td>Graphs, diagrams</td><td>Easy to handle</td></tr>
<tr><td>Fiber-tip pen (oil based)</td><td>×</td><td>×</td><td>×</td><td>◎</td><td>20</td><td>0.4~0.7</td><td>OHP</td><td>Highly volatile</td></tr>
<tr><td>Fiber-tip pen (water based)</td><td>◎</td><td>○</td><td>○</td><td>×</td><td>25</td><td>0.3~0.7</td><td>Graphs, diagrams</td><td>Good ink adhesion</td></tr>
<tr><td>Ceramic pen</td><td>×</td><td>○</td><td>◎</td><td>×</td><td>10</td><td>0.3~0.7</td><td>Drafting</td><td>Easy to handle</td></tr>
<tr><td rowspan="2">Ink pen</td><td>×</td><td>○</td><td>◎</td><td rowspan="2">×</td><td rowspan="2">10</td><td>0.3~0.8</td><td rowspan="2">Drafting</td><td rowspan="2">Care needed during use.</td></tr>
<tr><td>×</td><td>×</td><td>○</td><td>0.2</td></tr>
<tr><td>Characteristics</td><td>Good ink adhesion. Clear drawing.</td><td>Little expansion and contraction of paper.</td><td>Can be wet-copied.</td><td>For OHP only.</td><td></td><td></td><td></td><td></td></tr>
</table>

◎ Most suitable ○ Possible × Not possible

Note that the 0.2 ink pen differs in function from ink pens of 0.3 or more.

D) Characteristics of papers

(1) Measurement paper
(leaf paper SP325)

- Expansion and contraction of paper due to humidity changes are small.
- Little smudging of ink.
- Wet copying is possible to some extent.
- The adhesion of ink is relatively weak at high plotting speeds.

(2) Glossy blank paper
(leaf paper PL501)

- The adhesion of ink is good because the surface is smooth.
- Clear drawings since the paper is extremely white.
- Expansion and contraction due to humidity changes are larger than those of the measurement paper.
- Not suitable for ink pens since it takes time for the ink to soak into the paper.

(3) Tracing paper
(leaf paper PL507)

- Drawings can be wet-copied.
- Expansion and contraction due to humidity changes are large.
- Not suitable for pens other than ink pens and ceramic pens.

(4) Transparent film
(leaf paper PL508)

- Use for OHP drawing.
- Only fiber-tip pens (oil based) can be used.

Table 3-7-1 Suitability of pens for each type of paper
(Use this table for reference)

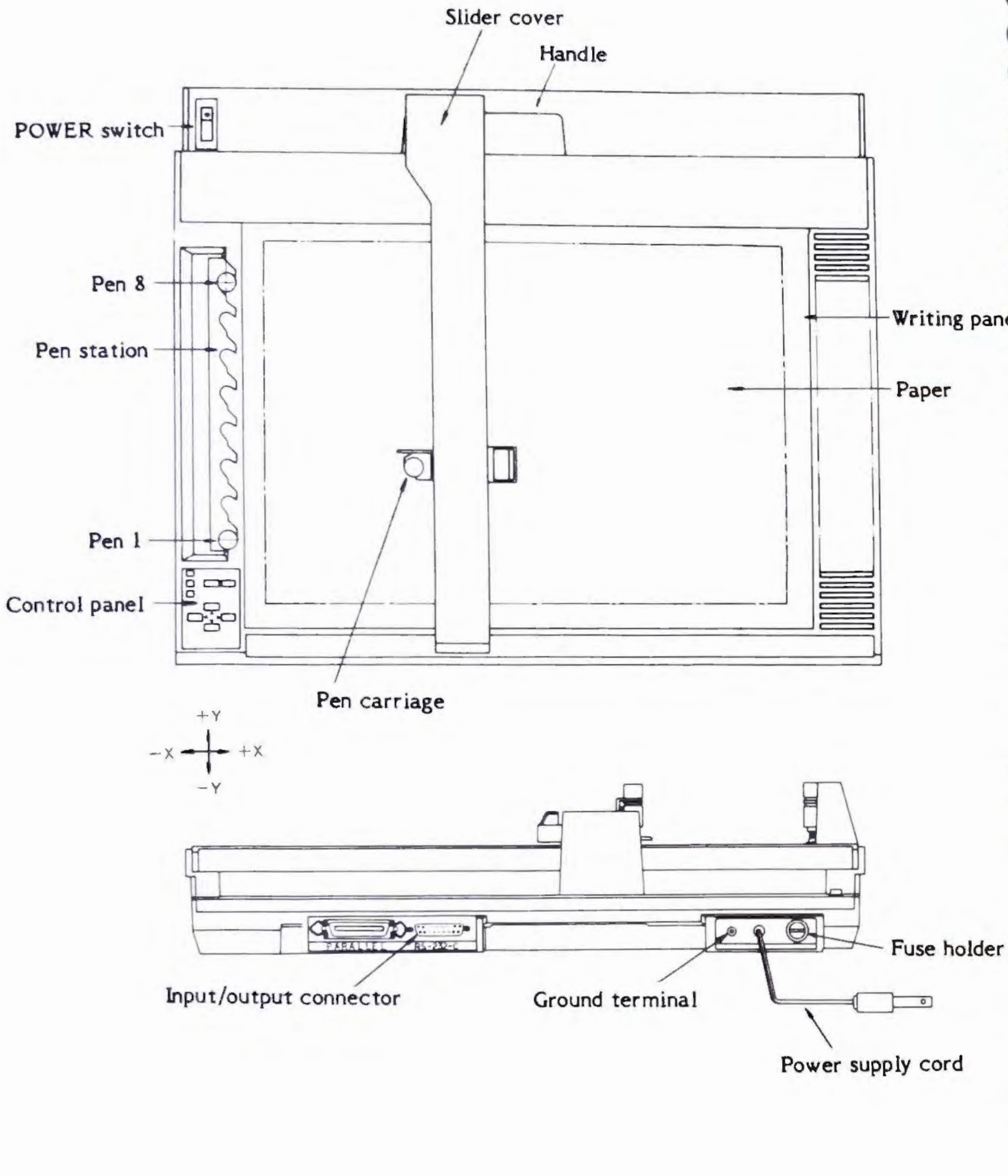
Type of paper / Type of pen	Coated paper PL501	Measurement paper SP325	Tracing paper PL507	Film PL508	Max. plotting speed (cm/s)	Line width (mm)	Main usage	Characteristics
Ball-point pen (water based)	◎	○	○	×	25	0.2～0.3	Graphs, diagrams	Easy to handle
Fiber-tip pen (oil based)	×	×	×	◎	20	0.4～0.7	OHP	Highly volatile
Fiber-tip pen (water based)	◎	○	○	×	25	0.3～0.7	Graphs, diagrams	Good ink adhesion
Ceramic pen	×	○	◎	×	10	0.3～0.7	Drafting	Easy to handle
Ink pen	×	○	◎	×	10	0.3～0.8	Drafting	Care needed during use.
	×	×	○			0.2		
Characteristics	Good ink adhesion. Clear drawing.	Little expansion and contraction of paper.	Can be wet-copied.	For OHP only.				

◎ Most suitable ○ Possible × Not possible

Note that the 0.2 ink pen differs in function from ink pens of 0.3 or more.

4. NOMENCLATURE AND FUNCTIONS OF PARTS

4-1 Nomenclature



o POWER switch

Power is on when the side marked $\boxed{\cdot}$ is down.

o Fuse holder

Use a 1A fuse (gray fuse cap) when the power supply is 100, 110 or 117 VAC.

Use a 0.5A fuse (black fuse cap) when the power supply is 200, 220 or 240 VAC.

o Ground terminal (screw diameter: 6 mm)

Connected to the mid-point of the filter.

4-2 Control panel

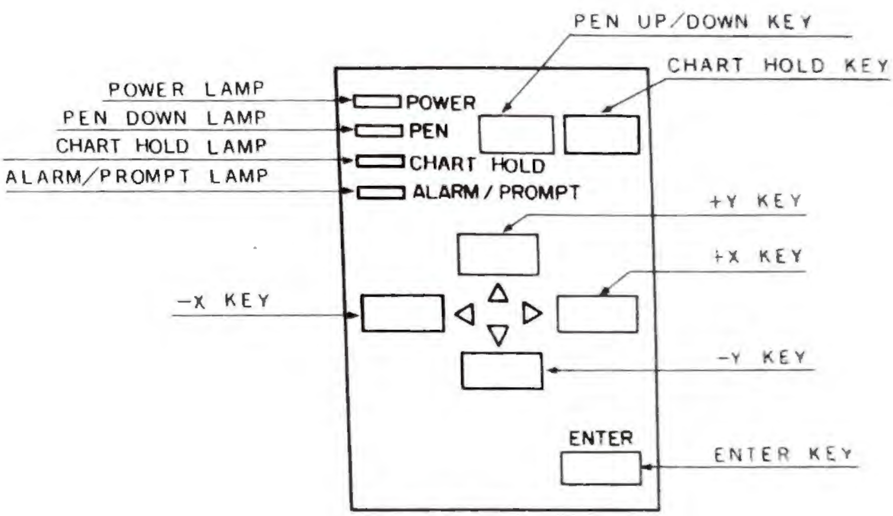


Fig. 4-2-1

Indicator lamps

POWER lamp (green):	Lights when power is on.
PEN DOWN lamp (green):	On when the pen is down.
CHART HOLD lamp (green):	Lights when the plotter is in CHART HOLD mode
ALARM/PROMPT lamp (red):	Lights when there is an error. Flashes when a CALL GIN or PROMPT LIGHT command is received.

Control keys

PEN UP/DOWN key:	Used to switch over between pen-up and pen-down. Raises or lowers the pen (carriage).
CHART HOLD key:	When this switch is pressed, the paper is held to the writing panel (electrostatic adhesion panel)
ENTER key:	The current position (coordinates) of the pen is transmitted to the external controller if this key is pressed during a CALL GIN command.
+X key:	Used to move the pen manually in the +X direction.
-X key:	Moves the pen in the -X direction.
+Y key:	Moves the pen in the +Y direction.
-Y key:	Moves the pen in the -Y direction.

Note: Chart hold on/off is controlled by pressing the CHART HOLD key itself, and is not affected by clear or interface clear commands. However, the chart hold is always off when the plotter is initialized (when the power is turned on).

4-3 Description of tests

The various tests are carried out by holding down specified keys and turning the power on at the same time. As explained in the previous section, the CHART HOLD function is off when the plotter is initialized (power is turned on).

To ensure that the paper adheres to the writing panel while the tests are being carried out, turn the power on, press the CHART HOLD switch, smooth the paper, and then turn the power off again. Proceed with the tests as explained below, but be sure to press the CHART HOLD switch once again after each self-test starts.

4-3-1 Self-test mode

The MP2300 is provided with a self-test function which enables it to test itself. The self-test pattern shown in Fig. 4-3-1 is drawn by this function.

Method of operation

Confirm that the power is off, and set the paper and pens. Next, turn the power switch on while holding down the -X key. The MP2300 will immediately start drawing the self-test pattern.

To stop this test midway, turn the power switch off. If this test pattern is drawn, the MP2300, except for the interface, is operating correctly. When the plotter has finished drawing the test pattern, it starts it again.

Note: Once the power has been turned on, pressing the -X key does not start the drawing of the self-test pattern.

Note: Check that there is no pen attached to the pen carriage before turning the power on. As soon as the power is turned on, the pen carriage goes to the pen station to pick up Pen 1, then draws the test pattern with it. Subsequent self tests are done after exchanging pens.

Example of drawing in self-test mode

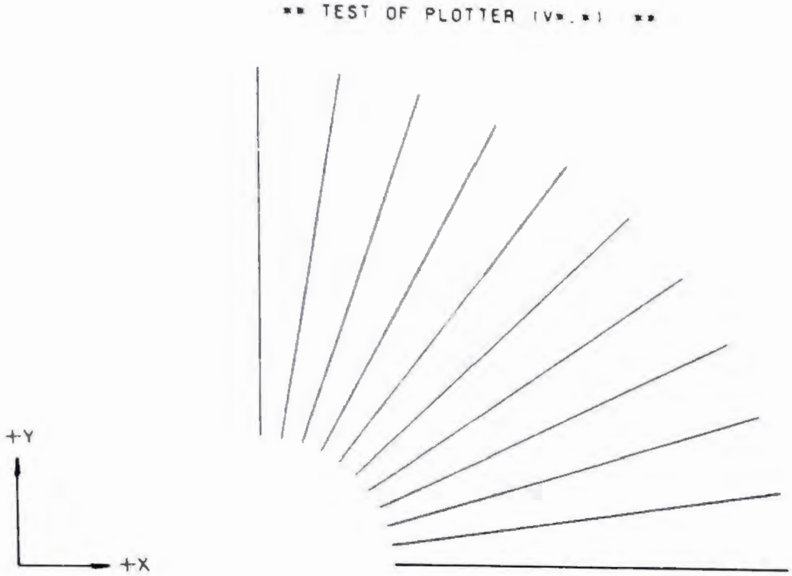


Fig. 4-3-1

4-3-2 Print mode (not available when plotter is in HP-GL command emulation mode)

The MP2300 has a function which can print character codes exactly as they were input. This is called print mode.

This function makes it possible to obtain a program listing, using the MP2300 instead of a printer.

Method of operation

> Confirm that the power is off, and set the recording paper and pens. Next, turn the power switch on while holding down the +Y (↑) key. The pen will move to the lower left corner of the plotting area and start to write the characters corresponding to the input codes in print mode. If a code with no character is input by mistake, it is written as a small, 2-digit hexadecimal number. When a terminator (line feed, etc.) is input, the plotter starts a new line.

This function is useful for making program listings or checking the input codes. Pressing the +Y key after the power is turned on will not activate print mode.

Up to 79 lines of 90 characters each can be written in print mode. When line 79 has been written and a terminator is received, the pen returns to its initial position. Change the paper and press the +Y key, the plotter will start writing characters again.

Note: Once the power has been turned on, pressing the +Y key will not activate print mode.
Cancel print mode by turning off the power switch.

Note: Check that there is a pen at position 1 of the pen station and no pen in the pen carriage before turning the power on.

Example of printout in print mode:


```
10 REM * PRINT MODE *
20 E$=CHR$(3)
30 LPRINT "M2400,1800,"
40 LPRINT "X1,100,6,10,0";E$
50 LPRINT "M2400,1800,"
60 LPRINT "X0,50,10,10,0";E$
70 LPRINT "AS30,Q25,"
80 FOR I=1 TO 5
90   READ C$
100    LPRINT "M";2390+I*100;1750
110    LPRINT "P";C$;E$
120 NEXT I
130 DATA A,B,C,D,E
140 FOR I=0 TO 10
150    LPRINT "M";2310;1790+I*50
160    LPRINT USING "P###I";I*10,E$
170 NEXT I
180 LPRINT "H"
190 END
```

Fig. 4-3-2

The example in Fig. 4-3-2 is a listing printed out when LLIST ↵ is keyed in from the computer's keyboard when the plotter is in print mode. (If this program is not stored in the computer, nothing is printed out. The method of outputting listings differs according to the type of interface or computer used.)

4-3-3 Interface test mode

In this mode, all data from the computer is printed out in the form of characters. This function can be used for debugging plotting data. (Data dump function.)

Method of operation

> Turn the power on while pressing the -Y (↓) key. The data received by the plotter will be printed in ASCII codes, as shown below. Characters not included in the code charts are printed as small, 2-digit hexadecimals.
>
> (Note that in this test mode, the plotter outputs dummy data in response to all READ commands from the plotter (such as the CALL GIN command), except for READ STATUS WORD 1 and 3. Be careful when processing such data.)

Example of printout in interface test mode

```
J40D 0A M 300          2400 0D 0A S80,080 0D 0A PFREQUENCY CHARACTERISTICS03 0D 0A M 2600
      2300 0D 0A S50,050 0D 0A J5,PDRAWN BY MP200003 0D 0A S30,030 0D 0A M 1200          100
 0D 0A J6,PFrequency03 0D 0A P    GRAPHTEC PLOTTER ﾃﾞ ｾｸﾃｷﾆｱｯﾀ ﾒﾓﾘﾉ ｸﾞﾗﾌｧ ｶｸｺﾄｶﾞ ﾃﾞｷﾏｽ03
0D 0A J10D 0A M 500          2194 0D 0A D 500          200 0D 0A M 676          200 0D 0A
D 676          2194 0D 0A M 898          2194 0D 0A D 898          200 0D 0A M 1044
  200 0D 0A D 1044          2194 0D 0A M 1199          2194 0D 0A D 1199          200 0D 0A M
 1375          200 0D 0A D 1375          2194 0D 0A M 1500          2194 0D 0A D 1500
 200 0D 0A M 1500          2194 0D 0A D 1500          200 0D 0A M 1676          200 0D 0A D 1
676          2194 0D 0A M 1898          2194 0D 0A D 1898          200 0D 0A M 2044          2
00 0D 0A D 2044          2194 0D 0A M 2199          2194 0D 0A D 2199          200 0D 0A M 23
75          200 0D 0A D 2375          2194 0D 0A M 2500          2194 0D 0A D 2500          20
0 0D 0A M 2500          2194 0D 0A D 2500          200 0D 0A M 2676          200 0D 0A D 2676
      2194 0D 0A M 2898          2194 0D 0A D 2898          200 0D 0A M 3044          200
0D 0A D 3044          2194 0D 0A M 3199          2194 0D 0A D 3199          200 0D 0A M 3375
      200 0D 0A D 3375          2194 0D 0A M 3500          2194 0D 0A D 3500          200 0D
0A M 3500          200 0D 0A D 500          200 0D 0A M 500          320 0D 0A D 3500
  320 0D 0A M 3500          390 0D 0A D 500          390 0D 0A M 500          440 0D 0A D
3500          440 0D 0A M 3500          479 0D 0A D 500          479 0D 0A M 500          51
0 0D 0A D 3500          510 0D 0A M 3500          537 0D 0A D 500          537 0D 0A M 500
      560 0D 0A D 3500          560 0D 0A M 3500          581 0D 0A D 500          581 0D
0A M 500          599 0D 0A D 3500          599 0D 0A M 3500          599 0D 0A D 500
  599 0D 0A M 500          719 0D 0A D 3500          719 0D 0A M 3500          789 0D 0A D
```

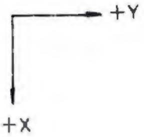


Fig. 4-3-3

Note: It is necessary to send data from a computer for this test.

4-3-4 Pen-test mode

This test mode checks whether the carriage can pick up the pens normally.

Method of operation

Confirm that the power is off, set the paper, and place eight pens in the pen station.

Next, turn the power switch on while holding down the three keys +X (→), -X (←) and -Y (↓) simultaneously.

The pen carriage will pick up each of the pens in turn, starting from Pen 1, and draw a square containing the number of that pen to the right of its pen position. After finishing with Pen 8, the pen carriage will return to the HOME position and wait for a plotting command in graphic mode.

Turn the power off to interrupt this test.

Note: Once the power has been turned on, pressing the +X (→), -X (←), and -Y (↓) keys will not activate pen-test mode.

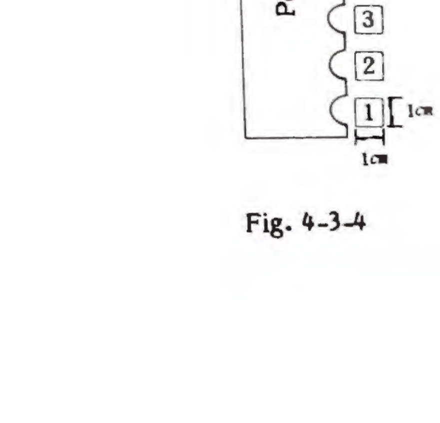


Fig. 4-3-4

4-3-5 Debugging mode

This mode reduces the buffer memory capacity from its normal 6 Kbyte in order to locate the position in a program which caused a plotting error during its execution.

Method of operation

Turn on the power while pressing the ENTER key. The buffer memory capacity is reduced according to the interface used, as shown below.

Centronics interface	10 bytes
GP-IB interface	10 bytes
RS-232-C interface	256 bytes

* The reduction quantity when using the RS-232-C interface depends on the handshake method.

Hardware handshake: DTR is off with 256 + 64 bytes
X ON/OFF handshake: X-off when the remaining space is 32 bytes, and X-on when it is 128 bytes.

Note: Once the power has been turned on, pressing the ENTER key will not activate debugging mode.
To cancel debugging mode, turn off the power switch.

4-3-6 Graphic mode

Use this mode to plot according to plotting commands from the computer. (Ordinary plotting is done in this mode.)

Method of operation

First set the paper and pens correctly. Confirm that there is no pen in the pen carriage and that Pen 1 is in the pen station.

Next, turn on the power switch and then press the CHART HOLD switch. The pen carriage will move to the HOME position and wait for a plotting command. If a program is run in this state, the pen carriage will automatically pick up Pen 1, unless a pen exchange is instructed by a plotting command, and carry out the plotting.

4-3-7 ROM and RAM checks

The ROM and RAM within the plotter are automatically checked when the power is turned on.

If any error is detected, the alarm lamp on the control panel will notify the operator. If this occurs, contact our service office.

- Alarm indication

  The alarm lamp (red) lights or flashes under the following circumstances.

  (1) When an error is found in the memory check performed when power is turned on. (See Table 4-3-1.)

Table 4-3-1 Memory error at power on

Error status	Alarm lamp status
ROM/RAM error	Flashing (once a second for 8 seconds, total 8 times)
RAM error	Flashing (once a second for 5 seconds, total 5 times)
ROM error	Flashing (once a second for 3 seconds, total 3 times)

Note: The operation after the indication of an error can not be guaranteed.
The ROM/RAM check is done only once when the power is turned on.

5. CONNECTION

5-1 Notes on connection

- When connecting the power cord and the connection cables to the computer, plug them in firmly so that they do not come out during operation.

- When connecting the MP2300 to a computer, draw the test pattern in self-test mode to check that the plotter is operating correctly (see Section 4-3-1).

- Before connecting the MP2300 to a computer, read through the interface literature of both the plotter and computer.

- Graphtec supplies a wide range of literature and the connection cables for use with various computers. The use of our connection cables is strongly recommended when connecting the plotter to a computer.

- When using one of the dual-purpose RS-232-C and Centronics interface connectors, do not insert a cable into the unused interface connector. The plotter may not operate if a cable is connected in this way.

5-2 Connection to computer

To connect peripheral equipment (the plotter in this case) to a computer, it is first necessary to determine the type of signals or the procedure used to transmit them, on both sides. The circuitry or procedure which enables the connection of each of the two pieces of equipment is called an interface.

Internationally standardized interfaces, which enable the easy connection of equipment which has the same type of interface, are called standard interfaces.

Centronics, RS-232-C, and GP-IB interfaces are the standard interfaces provided for the MP2300.

When connecting the MP2300 to a computer, carefully read the instruction manuals for the interfaces provided with both pieces of equipment, in addition to matching the interfaces on both sides.

The following describes the methods of connection to various representative computers.

5-2-1 Connection using Centronics interface

The Centronics interface is used for the printer of a computer. In most computers, this interface is connected to the printer terminal.

For the connection to the computer, use the connector shown in Table 5-2-1, which lists representative computers.

Note: Do not connect a cable to the RS-232-C interface connector when using the Centronics interface.

Table 5-2-1 Connection cables for Centronics interface

Computer name	Manufacturer	Cable name	Remarks
MSX models	Various	CA4001	Note that the printer interface is optional in some models.
PC-6001 PC-6001 mk II PC-6601 PC-8001 mk II PC-8801 PC-8801mk II PC-100 PC-9801 PC9801E/F	NEC	CA4001	Connect to printer terminal.
PC-8001	NEC	CA4002	Connect to printer terminal.
FM-7, New 7 FM-8	Fujitsu	CA4003	Connect to printer terminal.
FM-77 FM-11 series FM-16β	Fujitsu	CA4005	Connect to printer terminal
IF800 MODEL 20, 30	OKI	Use the cable provided with the IF80302.	Centronics parallel interface (IF80302) is necessary on the computer side.
IF800 MODEL 50	OKI	CA4005	Centronics parallel interface is necessary.
QC-10II	Epson	CA4005	Connect to printer terminal.

- Plotter's switch settings

The interface setting on the plotter side is done by setting the DIP switches S2 on the plotter's base, as shown in Fig. 5-2-1. The Centronics interface is enabled by turning off bit 1 of the ten-bit switches S2. Turn the plotter's power off before setting these switches.

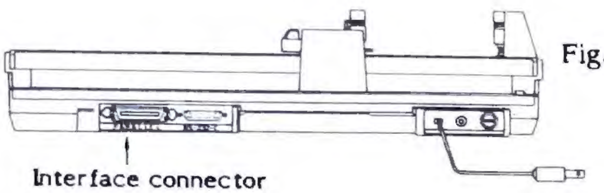
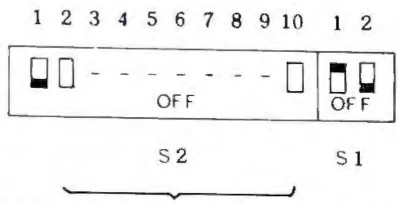


Fig. 5-2-1 Centronics interface

COMMAND MODE : FP



No need to set these positions; they are not used by Centronics.

- Connection to computer

Before connecting the plotter to a computer, confirm that the plotter is switched off.

Use the specified cable (see Table 5-2-1) for the connection to the computer. Plug the connector with the CPU seal into the computer's printer terminal and the connector with the PLOTTER seal into the plotter. (In some computers, plug the connector into the digital input-output port instead of the printer terminal.)

- Confirming the connection

To confirm the connection, operate the plotter by sending data from the computer. The examples given below are in BASIC, which is the usual language for personal computers. Refer to these examples and check the plotter's operation, using the method most suitable for your computer.

Check the operation in the following way. When the program shown below is keyed in and run, the plotter draws a circle of a radius of 50 mm, with the character string ABC .... XYZ inside it. The pen will return to the HOME position afterwards. (See Fig. 5-5-2.)

- Program listing

1) Example using NEC PC series, Fujitsu FM-7, New 7, FM-77 or FM11

```
10 REM * SAMPLE 5-2-1 *
20 LPRINT"W1000,1000,500,500,0,3600"+CHR$(3)
30 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
40 LPRINT"M";X;Y;"P";C$;CHR$(3)
50 LPRINT "H"
60 END
```

2) Example using Fujitsu FM-8

```
10 REM * SAMPLE 5-2-2 *
20 OPEN"O",#1,"LPT0:"
30 PRINT#1,"W1000,1000,500,500,0,3600":CHR$(3)
40 X=600:Y=1000:C$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
50 PRINT#1,"M";X;Y;"P";C$;CHR$(3)
60 PRINT#1,"H"
70 END
```

Note: If using the OKI IF800 series, change line 20 above to: 20 OPEN "LPT2:" AS#1.

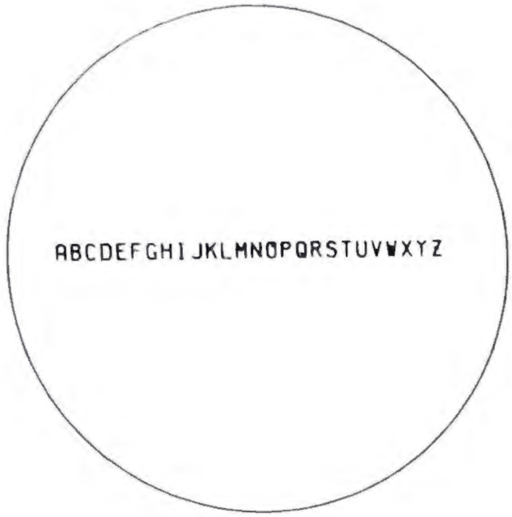


Fig. 5-2-2 Plotting example

5-2-2 Connection using RS-232-C interface

When using the RS-232-C interface for connection, the conditions for data transmission must be set the same way for both the computer and the plotter. Set these conditions carefully because otherwise the plotter may not operate normally.

The wiring of the connection cable may differ, depending on the computer used, so use the cable specified in Table 5-2-2 for connection to the computer. (This table lists representative computers.) Some examples of the connection of the MP2300 to a computer are given after Table 5-2-2.

Note: Do not connect a cable to the Centronics interface connector when using the RS-232-C interface.

Table 5-2-2 Connection cables for RS-232-C interface

Computer name	Manufacturer	Cable name	Remarks
PC-8001 mk II PC-8801 PC-8801 mk II PC-9801 PC-9801E/F PC-100	NEC	CA4631-52	Connect to the standard RS-232-C port.
PC-8001	NEC	CA4631-35	An expansion unit (PC-8011) is necessary on the computer side.
FM-7, New 7 (FM-8) FM-77	Fujitsu	CA4631-55	The MB22406 RS-232-C I/F card is necessary on the computer side. (Except for FM-8.)
FM-11 series FM-16β	Fujitsu	CA4631-79	Connect to the standard RS-232-C port.
IF-800 series	OKI	CA4631-30A	Connect to the standard RS-232-C port.
IBM5550	IBM	CA4631-82	An asynchronous transmission adapter is necessary on the computer side.
IBM XT IBM AT IBM JX	IBM	CA4631-99	An asynchronous transmission adapter is necessary on the computer side.
MZ-80B MZ-2000 MZ-2200	Sharp	CA4631-67	An RS-232-C I/F card (MZ-8BIO3) is necessary.

Computer name	Manufacturer	Cable name	Remarks
MZ-5500 MZ-6500	Sharp	CA4631-95	Connect to the standard RS-232-C port.
PASOPIA16	Toshiba	CA4631-83	Connect to the standard RS-232-C port.
MULTI-16 II	Mitsubishi	CA0002	Connect to the standard RS-232-C port.
MB16001	Hitachi	CA4631-86	Connect to the standard RS-232-C port.
MBC-2000, 3000	Sanyo	CA4631-20	Connect to the standard RS-232-C port.
M243, 343	Sord	CA4631-5A CA4631-19A	Connect to channel A of the standard RS-232-C port. Connect to channel B of the standard RS-232-C port.

6-1 Straight line drawing

6-1-1 How to use the basic commands

First, try drawing a triangle using two basic commands: the MOVE command which moves the pen when it is raised, and the DRAW command which draws straight lines.

Refer to your computer's manual for how to key in the program and operate the computer:

[N] [E] [W] [RETURN]	This erases the previous program.
⇩	
Program entry	Key in the program starting from line 10. Always press the [RETURN] key at the end of each line.
⇩	
[L] [I] [S] [T] [RETURN]	This displays the program listing on the CRT screen.
⇩	
Check program listing	Check for typing errors.
⇩	
Check settings	Check that the cables of the computer and plotter are connected, the plotter's paper and pen(s) are set, and the plotter is switched on.
⇩	
[R] [U] [N] [RETURN]	This runs the program.
⇩	
Plotting	

- Program listing

```
10 REM * SAMPLE6-1-1 *
20 E$=CHR$(3)
30 LPRINT "M300.400,"
40 LPRINT "D1000.400.650.1006.300.400";E$
50 END
```

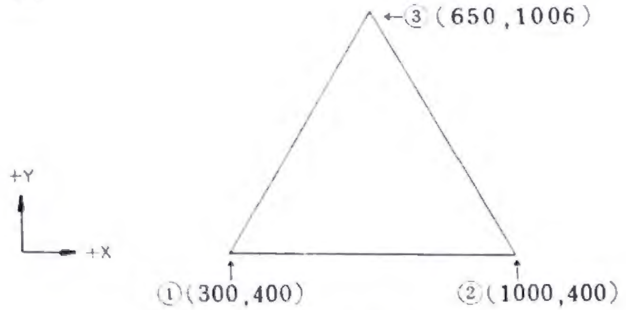


Fig. 6-1-2 Plotting example

- Explanation of program

10 Comment statement

20 Substitutes the character variable E$ for the terminator code (used in line 40).

30 Transmits the data within the double quote marks (" ") to the plotter.
The MOVE command makes the plotter move the raised pen 30 mm to the right and 40 mm upward from the origin to the position given by coordinates (300, 400).

40 Sends the DRAW command to the plotter. The plotter draws a triangle by moving the (lowered) pen through the points (1) - (2) - (3) - (1).
The ;E$ at the right end of the line sends the terminator defined in line 20 to the plotter, to indicate the end of the parameters of the DRAW command.

50 Indicates the end of the program.

In this program example, the first data output to the plotter is: LPRINT "M300, 400,".

When the characters within the double quote marks (" ") are sent to the plotter, the initial "M" is received as a MOVE command which moves the raised pen, and the plotter moves the pen to the coordinates given by the subsequent numbers, in this case (300, 400).

The last comma (,) acts to punctuate this command from the DRAW command "D" on the next line. In standard BASIC, carrier return and line feed (CR, LF) codes are output after each LPRINT statement, so this comma can be omitted. However, since some computers do not output the CR, LF codes, it is best to include the last comma.

The DRAW command in line 40 lowers the pen and draws a line as far as the specified coordinates. When drawing a continuous line connecting several points, as in this case, punctuate the coordinates by commas (,). There is no limit on the number of coordinate data points, and if the command gets too long, it can continue on the next line.

Note that a special code called a terminator (ETX), which indicates the end of data, is necessary at the end of commands like DRAW in which the number of coordinate data points is not fixed. In this example, the character variable E$ is first substituted as the terminator in line 20, and is output as ;E$ at the end of line 40.

6-1-2 How to use variables

Now modify the program given in Section 6-1-1 to enable output using variables. The figure drawn is the same as that of Fig. 6-1-2, but its position is moved slightly. Pen 2 is used.

- Program listing

```
10 REM * SAMPLE6-1-2 *
20 E$=CHR$(3)
30 READ X0,Y0,X1,Y1,X2,Y2,X3,Y3
40 LPRINT "M";X0;Y0
50 LPRINT "J2."
60 LPRINT "D";X1;Y1;X2;Y2;X3;Y3;E$
70 DATA 300,500,1000,500,650,1106,300,500
80 END
```

- Explanation of program

30 Reads the data on line 70 into each variable in sequence.

40 Moves the raised pen to the coordinates substituted into variables X0, Y0, by the MOVE command.

50 Picks up Pen 2 by the NEW PEN command "J".

60 Draws a line through the coordinates substituted into variables (X1, Y1) to (X3, Y3).

70 Indicates the coordinate data by the DATA statement.

When using variables, as in this case, they must be outside double quote marks (" "). If a variable is put within double quote marks, the variable name is sent to the plotter as a character, which will make the plotter operate incorrectly. Semicolons (;) are generally used to punctuate variables. (The semicolons are not sent to the plotter, each is replaced by a one-character space.)

Commas (,) can also be used for punctuation, but when a comma is used in standard BASIC, a 14-character space is inserted between the data points, so that unnecessary space codes are sent to the plotter. Therefore it is more convenient to use semicolons (;).

It is possible to send the number of a new pen to be picked up, using the NEW PEN command "J".

6-1-3 How to use commands to specify displacements

In the previous examples, movements of the pen were specified by coordinates from the origin. In the following example, pen movements are specified as a series of displacements which draw a triangle.

The line type specification makes the plotter draw triangles in short-short-long dashed lines, exchanging the pens in succession.

- Program listing

```
10 REM * SAMPLE6-1-3 *
20 E$=CHR$(3)
30 LPRINT "L8,B200,"
40 LPRINT "M300,1500,"
50 FOR I=1 TO 6
60   LPRINT "J";I
70   LPRINT "E606,-350,0,700,-606,-350";E$
80   LPRINT "O50,0,"
90 NEXT I
100 LPRINT "J1,L0,H"
110 END
```

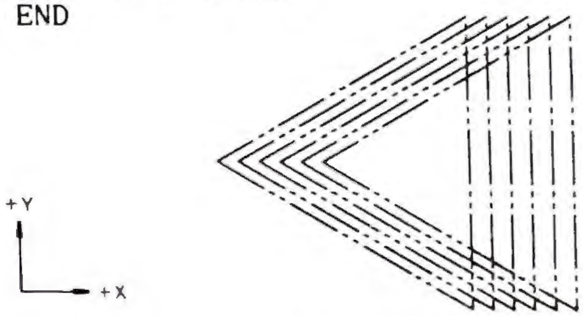


Fig. 6-1-3 Plotting example

- Explanation of program

30 Specifies short-short-long dashed lines by the LINE TYPE command "L8", and the pitch of the broken lines as 20 mm by the LINE SCALE command "B200".

40 Specifies the start point of the first triangle by the MOVE command.

50 Specifies 6 repeats by a FOR loop.

60 Outputs the NEW PEN command by a variable which specifies that Pens 1 to 6 are exchanged in succession.

70 Draws the triangle specified by the displacements given by the RELATIVE DRAW command "E".

80 Moves the raised pen over the distance specified by displacements given by the RELATIVE MOVE command "O".

90 The NEXT statement of the FOR loop.

100 Picks up Pen 1 again, returns the line type setting to solid line, and returns the raised pen to the HOME position by the HOME command "H".

RELATIVE MOVE and RELATIVE DRAW commands move the pen the specified displacement from its current position. These are useful for drawing the same figure at different positions or for repeating a plot.

The line type and pitch specifications are valid for drawing straight lines or curves. Once they are sent to the plotter, the setting remains valid until a new specification is given by those commands.

6-2 How to write characters

Characters can be written by putting the code "P", for PRINT command, in front of the characters to be written.

Specify the position of the characters by the MOVE command.

- Program listing

```
10 REM * SAMPLE6-2-1 *
20 E$=CHR$(3)
30 LPRINT "M300,2000,"
40 LPRINT "A"
50 LPRINT "PX-Y PLOTTER(ﾌﾟﾛｯﾀ)";E$
60 END
```

X-Y PLOTTER(ﾌﾟﾛｯﾀ)

Fig. 6-2-1 Plotting example

- Explanation of program

20 Substitutes the character variable E$ for the terminator code ETX.

30 Moves the raised pen to the start point of the characters.

40 Returns the character size and other characteristics to their initial settings by the ALPHA RESET command "A".

50 Writes characters according to the PRINT command "P".

When this program is run, the specified character string is written at a size of 3 mm, starting from the position (300, 2000).

The E$ at the end of line 50 acts as the terminator code defined in line 20, to indicate the end of data in the same way as in the DRAW command for straight line drawing.

If this terminator is not given, any commands input after this will also be drawn as characters.

6-2-2 How to specify the size and orientation of characters

The size, orientation, and slope of written characters can be specified as required. The method of specifying them is illustrated in the example below.

- Program listing

```
10 REM * SAMPLE6-2-2 *
20 E$=CHR$(3)
30 LPRINT "M500,2100,"
40 LPRINT "S100,Q80,"
50 LPRINT "R300,I93,"
60 LPRINT "PMP2300";E$
70 LPRINT "A"
80 END
```

Fig. 6-2-2 Plotting example

- Explanation of program

30 Moves the raised pen to the start point of the characters.

40 Specifies the height of character as 10 mm by the ALPHA SCALE command "S100" and the spacing of characters as 8 mm by the ALPHA SPACE command "Q80".

50 Specifies the orientation of characters as 30° by the ALPHA ROTATE command "R300" and their slope as 10° by the ALPHA ITALIC command "I93".

60 Writes the characters given by the PRINT command.

70 Resets all specifications relating to characters.

The specifications of commands relating to character print settings remain valid until they are changed or reset, which means that all the characters written after these commands are written at the size and orientation specified by them.

It is best to return all the settings relating to character printing to their initial values by the ALPHA RESET command whenever you have used these commands in a program, so that they do not affect the next program.

6-2-3 How to output characters as variables

This is an example of a program which outputs characters as variables.

When this program is run, the sentence "Input the points (X, Y)?" will be displayed on the CRT screen. In response, key in the position you want the characters to start at by, for example, 100, 2300 RETURN. This will move the pen to the position (100, 2300). The CRT will then display: "Input the characters:", so key in the characters you want written, and they will be printed.

- Program listing

```
10 REM * SAMPLE6-2-3 *
20 E$=CHR$(3)
30 LPRINT "AS50,Q50,"
40 INPUT "Input the points(X,Y)";X,Y
50 LPRINT "M";X;Y
60 LINE INPUT "Input the characters:";C$
70 LPRINT "P";C$;E$
80 END
```

- Explanation of program

20 Substitutes E$ for the terminator (ETX).

30 Returns all character settings to their initial values by the ALPHA RESET command "A".
The ALPHA SCALE command "S50" specifies the character size as 5 mm and the ALPHA SPACE command "Q50" specifies their spacing as 5 mm.

40 Inputs the coordinates of the point at which the character writing is to start.

50 Moves the raised pen to the coordinates which have been input.

60 Inputs the characters to be written.

70 Writes the character string substituted into C$, by the PRINT command "P".
E$ is the terminator indicating the end of the PRINT command.

6-2-4 How to write special characters

Use the CHR$ function to output special characters, such as Greek letters, which are not on the computer's keyboard. The numerals in parentheses after CHR$ give the code number for each character, as listed in the character code charts (see Tables 7-3-2 and 7-3-4). Ordinary alphanumerics can also be written by specifying their code numbers using the CHR$ function.

. Program listing

```
10 REM * SAMPLE6-2-4 *
20 E$=CHR$(3)
30 LPRINT "AS50.Q50."
40 LPRINT "M1000,2000,"
50 LPRINT "P";CHR$(225);"=";CHR$(240);"r*Sin(";CHR$(232);")";E$
60 END
```

. Explanation of program

50 Writes the whole of character string "α = π r * Sin (θ)", with the Greek letters specified by the PRINT command "P" in the following way: CHR$(225) gives "α", CHR$(240) gives "π", and CHR$(232) gives "θ".

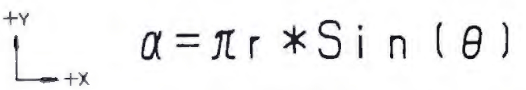


Fig. 6-2-3 Plotting example

6-2-5 How to display the values of numeric variables

This is an example of a program which makes the plotter write a value which is substituted into a numerical variable.

When this program is run, "Input an angle?" is displayed on the CRT screen. If you key in 60 $\boxed{\text{RETURN,}}$ for example, the computer will calculate the value of sine 60°, and make the plotter write the result of the calculation as shown in Fig. 6-2-4.

- Program listing

```
10 REM * SAMPLE6-2-5 *
20 E$=CHR$(3)
30 LPRINT "AS50,Q50,"
40 INPUT "Input an angle";TH
50 LPRINT "M1000,2200,"
60 LPRINT "PSIN(";TH;")=";E$
70 LPRINT USING "P#.####!";SIN(TH*3.1415926#/180),E$
80 LPRINT "H"
90 END
```

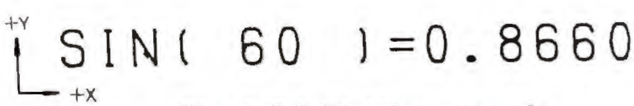


Fig. 6-2-4 Plotting example

- Explanation of program

40 Inputs the angle.

60 Writes the value of TH within the parentheses of "SIN( ) =".

70 Writes the result of the calculation made by the LPRINT USING statement, in the format specified.

```
LPRINT USING "P#.####!"
```

Terminator code output

Numeric format specification

PRINT command character

80 Moves the pen to the HOME position by the HOME command.

To make the plotter write the value of the numeric variable, output a PRINT command "P" and the numeric variable outside double quote marks (" "), as shown in line 60 of the above example.

If a numeric value is output by a LPRINT statement, as in line 60 above, a space is usually inserted before and after the numeric if it has a positive value.

To remove these spaces, or to specify the significant digits of the numeric, use an LPRINT USING statement such as that in line 70. (Refer to the manual provided with your computer for details.)

6-3 How to draw a circle

6-3-1 Basic method

It is easy to draw a circle using the CIRCLE command "W", by specifying the coordinates of its center, its radius, and rotation angles.

The CIRCLE command can not only draw a complete circle, it can also draw arcs, spirals, and polygons. The following is an example of a program using this command.

- Program listing

```
10 REM * SAMPLE6-3-1 *
20 E$=CHR$(3)
30 LPRINT "W1600,1500,250,250,0,3600";E$
40 LPRINT "W1600,1500,250,250,900,-2700,600";E$
50 LPRINT "W1600,1500,0,200,0,32767";E$
60 LPRINT "H"
70 END
```

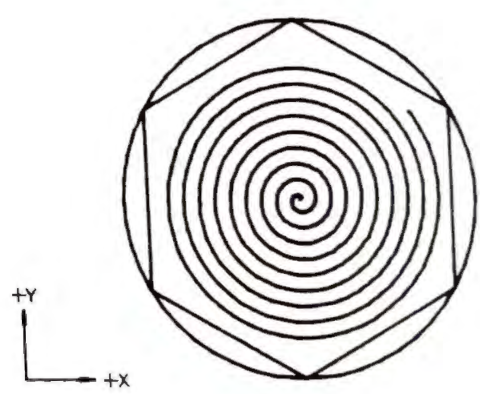


Fig. 6-3-1 Plotting example

. Explanation of program

30 Draws a circle centered on the coordinates (1600, 1500) and of a radius of 25 mm by the CIRCLE command "W", moving the pen counterclockwise from 0 to 360°.

```
LPRINT" W  1600,1500,250,250, 0 , 3600" ;E$
        |   |    |    |   |   |    |      |
        |   |    |    |   |   |    |      └─ Terminator
        |   |    |    |   |   |    └─ Final angle, 360°
        |   |    |    |   |   └─ Initial angle
        |   |    |    |   └─ Final radius
        |   |    |    └─ Initial radius
        |   |    └─ Y coordinate of center
        |   └─ X coordinate of center
        └─ CIRCLE command
```

40 Draws a hexagon by the CIRCLE command, moving the pen clockwise from the top right. The final parameter is the segment angle (60°).

50 Draws a spiral by the CIRCLE command, moving the pen counterclockwise through 3276.7° (maximum value) while the radius increases from 0 to 20 mm.

60 Returns the pen to the HOME position by the HOME command "H".

Specify the coordinates and radii in units of 0.1 mm, and angles in units of 0.1°. The segment angle (number of segments) can be omitted, so output the terminator E$ at the end of the CIRCLE command.

Angles are based on the X-axis, and the direction in which the circle is drawn is determined by the relative size of the initial and final angles. In other words, the circle is drawn counterclockwise when the initial angle is smaller than the final angle, and clockwise when the initial angle is the larger.

6-3-2 How to round the corners of a square using arcs

The RELATIVE CIRCLE command makes it easy to draw arcs or circles without specifying their centers. This makes it possible to round the corners of a square by drawing arcs continuing from straight lines.

This is an example of a program using this command.

- Program listing

```
10 REM * SAMPLE6-3-2 *
20 E$=CHR$(3)
30 LPRINT "M1500.700.E300.0":E$
40 LPRINT "]50,50.-900,0";E$
50 LPRINT "E0,200";E$
60 LPRINT "]50,50,0.900":E$
70 LPRINT "E-300.0";E$
80 LPRINT "]50.50,900,1800":E$
90 LPRINT "E0,-200";E$
100 LPRINT "]50,50,1800,2700";E$
110 LPRINT "H"
120 END
```

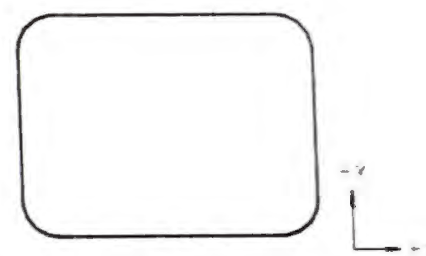


Fig. 6-3-2 Plotting example

- Explanation of program

30 Draws a 30-mm straight line to the right from the point (1500, 700).

40 Draws an arc of a radius of 5 mm from -90° to 0° by the RELATIVE CIRCLE command "]".

50 Draws a 20-mm straight line upward.

60 Draws an arc of radius 5 mm from 0° to 90°.

70 Draws a 30-mm straight line to the left.

80 Draws an arc of radius 5 mm from 90° to 180°.

90 Draws a 20-mm straight line downward.

100 Draws an arc of radius 5 mm from 180° to 270°.

110 Returns the pen to the HOME position.

6-4 How to draw a curve

6-4-1 Basic method

Use the CURVE or RELATIVE CURVE command to make the plotter draw a curve by interpolating between specified data points with cubic curves. This is an example of a program using the CURVE command.

. Program listing

```
10 REM * SAMPLE6-4-1 *
20 E$=CHR$(3)
30 LPRINT "Y0,1300,340,1420,450,1480,160,"
40 LPRINT "1580,530,1660,80,1810,450,"
50 LPRINT "1880,160,1980,330";E$
60 LPRINT "H"
70 END
```

Fig. 6-4-1 Plotting example

- Explanation of program

20 Substitutes E$ for the terminator (ETX).

30 Specifies an open curve and outputs data by the CURVE command "Y0,".

40 Continues the data output.

50 Continues the data output, with a terminator at the end to complete the CURVE command.

The CURVE command has open curve and closed curve specifications. An open curve is specified in this program example, but if a closed curve is specified, the start and end points of the data are connected to form a closed curve.

Specify a closed curve by making the CURVE command "Y1,". There must be at least three points in the curve data, and there must be a terminator at the end of the last data point.

6-4-2 Data output using variables

This is an example of a program in which the data of a curve is defined by DATA statements and is output as variables.

The data used here is the same as that in Section 6-4-1, so the plot is the same as that of Fig. 6-4-1.

- Program listing

```
10 REM * SAMPLE6-4-2 *
20 E$=CHR$(3)
30 LPRINT "Y0,"
40 FOR I=1 TO 100
50   READ X,Y:IF X+Y=0 THEN 80
60   LPRINT X;Y
70 NEXT I
80 LPRINT E$
90 LPRINT "H"
100 DATA 1300,340,1420,450,1480,160
110 DATA 1580,530,1660,80,1810,450
120 DATA 1880,160,1980,330,0,0
130 END
```

- Explanation of program

20 Substitutes E$ for the terminator (ETX).

30 Outputs the CURVE command with open curve specification "Y0,".

40 FOR loop (the 100 of FOR I = 1 TO 100 must be at least 9 in this case).

50 Reads curve data into the variables X, Y. If the data is (0, 0), data input is finished, so control jumps to line 80.

60 Outputs the curve data.

70 Repeats the FOR loop by the NEXT statement.

80 Outputs the terminator to complete the CURVE command.

90 Returns the pen to the HOME position.

100 - 120

Curve data (The final (0, 0) indicates the end of the curve data).

Curve data is often output as variables. The method shown in this example, in which curve data is output in the form of a FOR - NEXT loop sandwiched between the CURVE command and the terminator, makes it possible to output an unlimited amount of data.

Array variables can also be used.

Note that in this method, the command's terminator is initially set as the ETX code (03H), so the CURVE command does not end even when the command and the data output are not on the same line. However, if the terminator is changed to the codes CR, LF (Carriage Return, Line Feed) by the TERM command, the curve is not drawn when the command and the curve data are on different lines.

6-5 How to draw coordinate axes

When drawing a bar graph or line graph, it is necessary to insert graduated coordinate axes. This can be done easily by using the AXIS command "X". This is an example of a program using this command.

- Program listing

```
10 REM * SAMPLE6-5-1 *
20 E$=CHR$(3)
30 LPRINT "M2400,1800,"
40 LPRINT "X1,100,6,10,0";E$
50 LPRINT "M2400,1800,"
60 LPRINT "X0,50,10,10,0";E$
70 LPRINT "AS30.Q25,"
80 FOR I=1 TO 5
90   READ C$
100    LPRINT "M";2390+I*100;1750
110    LPRINT "P";C$;E$
120 NEXT I
130 DATA A,B,C,D,E
140 FOR I=0 TO 10
150    LPRINT "M";2310;1790+I*50
160    LPRINT USING "P###!";I*10,E$
170 NEXT I
180 LPRINT "H"
190 END
```

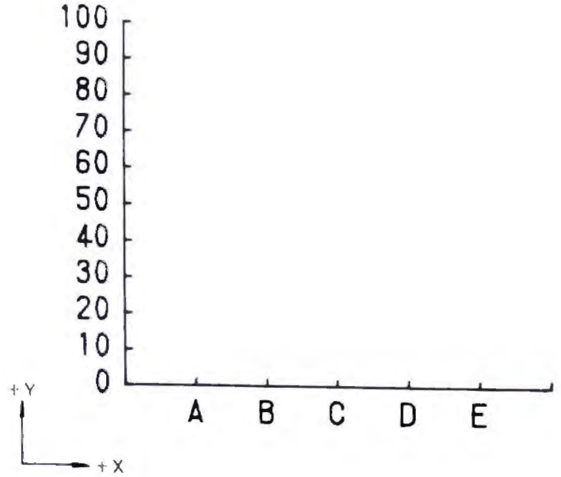


Fig. 6-5-1 Plotting example

Explanation of program

20 Substitutes E$ for the terminator.

30 Moves the pen to the start point of the coordinate axes.

40 Draws the X-axis (horizontal axis).

```
LPRINT "X1,100,6,10,0";E$
```

Terminator
Length of scale marks in negative direction
Length of scale marks in positive direction
Number of repeats of graduations
Length of each graduation
X-axis direction specification
AXIS command

50 Moves the pen to the start point for the next axis.

60 Draws the Y-axis (vertical axis).

70 Sets the size of characters to 3 mm and their spacing to 2.5 mm.

80 - 130
Inserts item names along the horizontal axis.

140 - 170
Inserts the numbers 0 - 100 along the vertical axis.

180 Returns the pen to the HOME position.

There are two ways of specifying graduations when drawing coordinate axes. One is the method used in the example given above, in which a unit length and number of repeats is specified. The other method is to specify the total length of the axis and a number of divisions. See the section on this command for how to specify these parameters.

The LPRINT USING statement can be used for inserting values into a scale, as in this example, to provide a clear graph.

6-6 HATCHING command

6-6-1 Hatching of bar graph

The HATCHING command can be used when drawing a bar graph, to insert hatching into the bars easily.

This is an example of how to use the HATCHING command.

When this program is run, a bar graph is plotted within the coordinate axes shown in Fig. 6-5-1, to provide the graph shown in Fig. 6-6-1.

- Program listing

```
10 REM * SAMPLE6-6-1 *
20 E$=CHR$(3)
30 FOR I=1 TO 5
40   READ D
50   LPRINT "J";I+1
60   LPRINT "M";2360+I*100;1800
70   LPRINT "%";3;80;D*5;20;450;E$
80 NEXT I
90 DATA 20,43,66,100,72
100 LPRINT "J1,H"
110 END
```

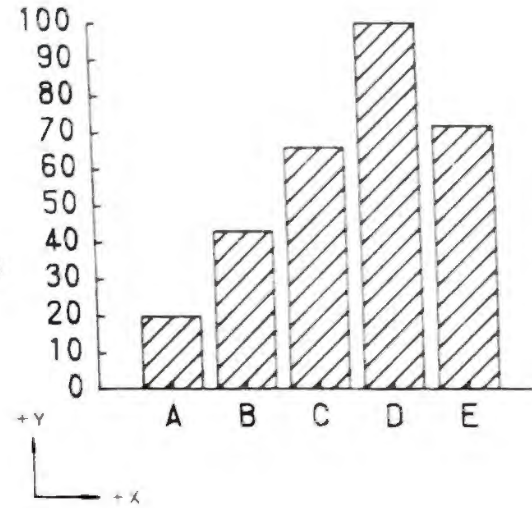


Fig. 6-6-1 Plotting example

- Explanation of program

20 Substitutes E$ for the terminator.

30 Repeats the FOR loop five times.

40 Reads bar graph data.

50 Exchanges pens in turn from Pen 2 to Pen 6.

60 Moves the pen to the start point of the bar graph.

70 Draws the bar graph.

```
LPRINT "%" ; 3 ; 80 ; D*5 ; 20 ; 450 ; E$
```

Terminator
Slope of hatching (45°)
Line spacing of hatching (2 mm)
Calculation of bar length in Y-axis direction
Width of bars in X-axis direction (8 mm)
Type of hatching (hatching of bar graph)
HATCHING command

80 Repeats the FOR loop by the NEXT statement.

90 Defines the bar graph data.

There are several types of HATCHING command to provide hatching within a square, segment, or any string of points, etc. These are selected by the parameter after the "%" of the HATCHING command. See the description of the HATCHING commands for details.

6-6-2 Hatching of circular graph

This is an example of a program which uses the HATCHING command to hatch fan shapes. A circular graph can be drawn with this function.

- Program listing

```
10 REM * SAMPLE6-6-2 *
20 E$=CHR$(3)
30 LPRINT "M2700,1200,"
40 LPRINT "J1,%13,300,100,900,-450,20,450";E$
50 LPRINT "J2,%13,300,100,-450,-1800,20,-450";E$
60 LPRINT "J3,%13,300,100,-1800,-2700,10,900";E$
70 LPRINT "J1,H"
80 END
```

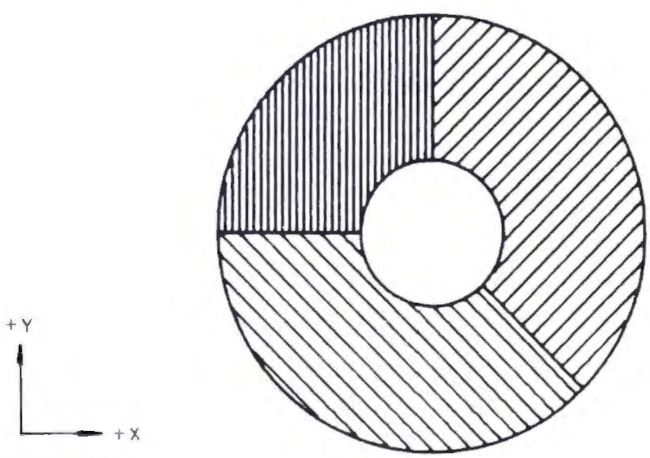


Fig. 6-6-2 Plotting example

• Explanation of program

20 Substitutes E$ for the terminator (ETX).

30 Moves the pen to the coordinates of the center of the circular graph.

40 Selects Pen 1, draws a fan shape, and hatches it with a line spacing of 2 mm and a slope to the right of 45°, by the HATCHING command "%".

```
LPRINT"J1,%13,300,100,900,-450,20,450";E$
```

Terminator
Hatching angle
Hatching line spacing
Final angle of fan shape
Initial angle of fan shape
Radius of inner circle
Radius of outer circle
Specification of hatching in fan shape
HATCHING command
NEW PEN command

50 Selects Pen 2, draws a fan shape extending from -45° to -180°, and hatches it with a line spacing of 2 mm and a hatching angle of 45° to the left.

60 Selects Pen 3, draws a fan shape extending from -180° to -270°, and hatches it with vertical lines at a spacing of 1 mm.

70 Selects Pen 1 again and returns to the HOME position.

6-6-3 Hatching within string of points

The HATCHING command can also hatch within a given string of points. This function makes it easy to hatch within complicated shapes, such as those used in drafting.

This is an example of a program which uses this function.

- Program listing

```
10 REM * SAMPLE6-6-3 *
20 E$=CHR$(3)
30 LPRINT "%23,10,900,"
40 FOR I=1 TO 100
50   READ X,Y:IF X+Y=0 THEN 80
60   LPRINT X;Y
70 NEXT I
80 LPRINT E$
90 LPRINT "H"
100 DATA 2440,550,2640,200,2840,650,3040,200,3240,550,0,0
110 END
```

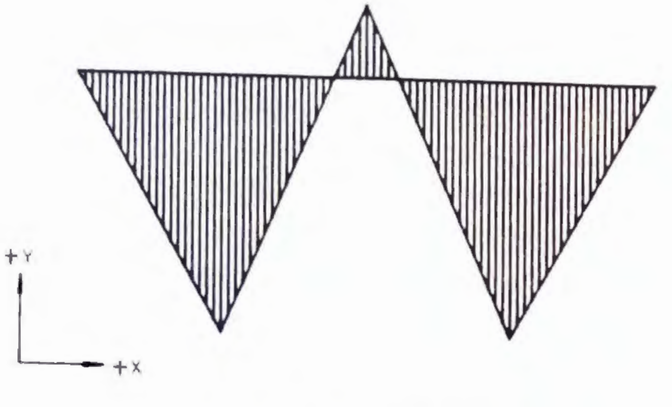


Fig. 6-6-3 Plotting example

- Explanation of program

20 Substitutes E$ for the terminator (ETX).

30 Specifies hatching within a string of points by the HATCHING command "%23,". The hatching is vertical lines at a spacing of 1 mm.

40 FOR loop (in this case, the final value must be at least 6).

50 Reads in data on the string of points. Data ends when the coordinates are (0, 0).

60 Sends the data on the string of points to the plotter.

70 NEXT statement for the FOR loop.

80 Outputs the terminator to complete the HATCHING command.

90 Returns the pen to the HOME position.

100 Data on the string of points.

6-7 Application examples

It is possible to draw graphs using only the commands described so far, but polar coordinate commands can make graph drawing much easier.

This section gives two practical methods of drawing circular graphs and radar charts, using the polar coordinate commands. Use them for reference when writing your own programs.

Listing of program for drawing circular graph

```
100 DIM A$(10),B(10)
110 A=0:I=1:C1=0
120 E$=CHR$(3)
130 READ A$(I)
140 IF A$(I)="END" THEN 190
150 READ B(I)
160 A=A+B(I)
170 I=I+1
180 GOTO 130
190 LPRINT"^P1000,1000,900";-A;E$
200 FOR J=1 TO I-1
210 C2=C1+B(J)
220 PN=(JMOD8)+1
230 LPRINT"J";PN
240 LPRINT"MP0,0";E$
250 LPRINT"%13,500,200,"C1;C2;30;A/8*J;E$
260 C3=(C2-C1)/2+C1
270 LPRINT"RP";C3;250;450;E$
280 LPRINT"LP1";E$
290 IF C3>A/2 THEN LPRINT"LP7";E$
300 LPRINT"^K ";A$(J);E$;"LP7";E$;"P";
    CHR$(10);"(";B(J);")";E$
310 C1=C2
320 NEXT J
330 LPRINT"^J1,"
340 LPRINT"MP200,0";E$
350 LPRINT"J200,200,900,4500";E$
360 LPRINT"MP500,0";E$
370 LPRINT"J500,500,900,4500";E$
380 LPRINT"LP4";E$
390 LPRINT"MP25,0";E$
400 LPRINT"Kコ゛ウケイ";E$
410 LPRINT"MP-25,0";E$
420 LPRINT"P";A;E$
430 LPRINT"A"
440 END
1000 DATA トウキョウ,621,カンサイ,445,トウホク,407,
     チュウブ゛,268,カントウ,181,ホッカイト゛ウ,80,END
```

Listing of program for drawing radar chart

```
100 E$=CHR$(3)
110 LPRINT"^P2000,1000,900,-7";E$
120 LPRINT"LP4";E$
130 FOR I=0 TO 6
140 LPRINT"RP";I;1100;0;E$
150 IF I>0 THEN LPRINT"LP1";E$
160 IF I>3 THEN LPRINT"LP7";E$
170 READ A$
180 LPRINT"P";A$;E$
190 NEXT I
200 FOR J=0 TO 10
210 LPRINT"MP";J*100;"0";E$
220 LPRINT"LP4";E$
230 LPRINT"P";J;E$
240 LPRINT"L4,B50,"
250 LPRINT"MP";100*J;0;E$
260 LPRINT"J";100*J;100*J;900;4500;E$
270 NEXT J
280 LPRINT"L0,B100,"
290 FOR J=1 TO 3
300 LPRINT"J";J+1
310 READ B
320 B0=B*100
330 LPRINT"MP";B0;0;E$
340 FOR I=1 TO 6
350 READ B
360 LPRINT"DP";B*100;I;E$
370 NEXT I
380 LPRINT"DP";B0;0;E$
390 LPRINT"LP2";E$
400 LPRINT"MP1500,1";E$
410 LPRINT"O10";-J*100
420 LPRINT"E100,0";E$
430 LPRINT"P No.";J;E$
440 NEXT J
450 LPRINT"A"
460 END
1000 DATA SUNDAY,MONDAY,TUESDAY,WEDNESDAY,
     THURSDAY,FRIDAY,SATURDAY
1010 DATA 9,6,7,3,5,4,8
1020 DATA 7,7,8,6,2,1,5
1030 DATA 5,1,6,4,3,3,10
```

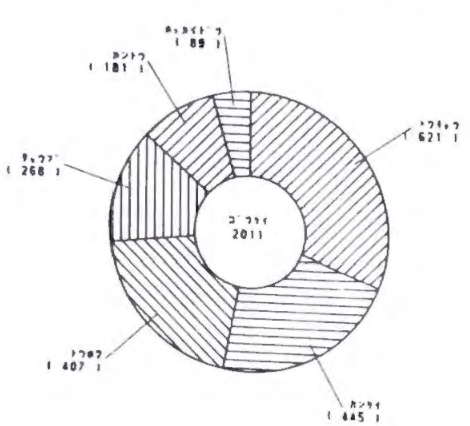


Fig. 6-7-1

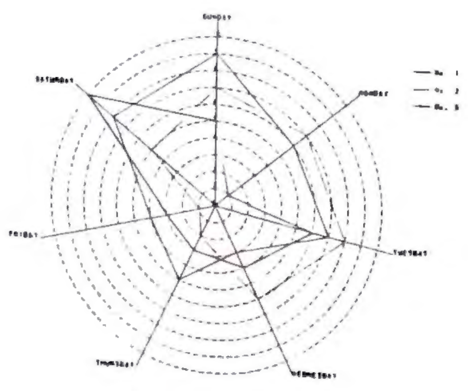


Fig. 6-7-2

6-7-1 Circular graph

This section describes the program for drawing a circular graph.

```
100 DIM A$(10),B(10)
110 A=0:I=1:C1=0
120 E$=CHR$(3)
```

100: Array declaration

110: Initialization of variables

120: Specification of terminator

Data read-in

```
130 READ A$(I)
140 IF A$(I)="END" THEN 190
150 READ B(I)
160 A=A+B(I)
170 I=I+1
180 GOTO 130
```

A$(I): Character variable for item names

B(I): Numeric variable for data

140: End-of-data detection

160: Calculation of total amount of data

* This value is used to express 360°.

Specification of polar origin

```
190 LPRINT"^P1000,1000,900";-A;E$
```

$\underbrace{\text{1000,1000}}_{①}$, $\underbrace{\text{900}}_{②}$, $\underbrace{\text{-A}}_{③}$

This specifies the polar origin as (1000, 1000). This point is used as the center of the circular graph. Because it is a circular graph, the +Y direction must be set to 0, so (2) rotates the polar coordinate system through 90° (900).

Normally, the data values must all be converted into proportional values with 360° expressed as 100%. However, if the total volume of data is input, as in (3), each data value can be automatically converted into a proportional value. In this example, (3) has a negative value so that angles are measured positively in the clockwise direction. (In the initial setting, they are measured positively in the counterclockwise direction.)

Graph plotting

```
200 FOR J=1 TO I-1
        ⁞
320 NEXT J
```

This part of the program writes all the items, item names, and their values.

I-1 is specified because the counter of line 170 includes the detection of the "END", indicating data end, as part of the count.

```
210 C2=C1+B(J)
220 PN=(JMOD8)+1
230 LPRINT"J";PN
```

210: Specifies the final angle when drawing one item.

220
:
230 Specify that the color is changed for each item. The number of the pen used is calculated by adding 1 to the remainder obtained by dividing J by 8. The plotting starts with Pen 2.

```
240 LPRINT"MP0,0";E$
250 LPRINT"%13,500,200,"C1;C2;30;A/8*J;E$
```

240: Moves the raised pen to the polar origin.

250: Plots the data for each item.

This draws a fan shape from C1 to C2 (the data values for each item), and hatches inside it at a line spacing of 3 mm (30) and at an angle which is 45° greater than the hatching of the previous item. The data given in these lines can be used as graph-plotting data without any conversion.

The hatching angle is increased by 45° for each data item.

```
260 C3=(C2-C1)/2+C1
270 LPRINT"RP";C3;250;450;E$
```

260: Determines the angle of each pointer line.

270: Draws a pointer line for the name of each item.

These lines draw a pointer line for the name of each item. The angle of each pointer is calculated by line 260 so that it starts from the center of the corresponding item.

Each pointer is 25 mm (250) long and starts from a point whose polar coordinates are 45 mm (450) from the polar origin, at the angle C3.

```
280 LPRINT"LP1";E$
290 IF C3>A/2 THEN LPRINT"LP7";E$
300 LPRINT""K ";A$(J);E$;"LP7";E$;"P";CHR$(10);"(";B(J);")";E$
```

These lines write the name of each item and a data value. The start point of character printing varies according to the plotting position.

CHR$(10) functions as a LF (Line Feed) command.

280: Specifies the start point (bottom left of the first character) for the writing of the item name.

290: Changes the position of the item name if its data exceeds 50% of the total. (Bottom right of last character).

300: Prints the item name and data value on two lines.

```
310 C1=C2
```

310: Sets the final angle of the fan shape drawn by line 250 as the initial angle of the next item.

```
330 LPRINT""J1,"
340 LPRINT"MP200,0";E$
350 LPRINT"J200,200,900,4500";E$
360 LPRINT"MP500,0";E$
370 LPRINT"J500,500,900,4500";E$
```

330: Selects Pen 1.

340 : 350 Draw the inner circle.

360 : 370 Draw the outer circle.

This part redraws the inner and outer circles of the circular graph which have just been completed, to make the graph more visible. (The color changes for each item.)

The initial angle of the plot is defined as 900 by line 350, which is not influenced by the "∧P" command, in order to make all the start points of the plot the same. (This is "∧P" because of the JIS codes.)

```
380 LPRINT"LP4";E$
390 LPRINT"MP25,0";E$
400 LPRINT"Kｺﾞｳｹｲ";E$
410 LPRINT"MP-25,0";E$
420 LPRINT"P";A;E$
430 LPRINT"A"
440 END
```

380: Specifies the start point of the characters to be written at the center of the graph. (The bottom right of the character at the center of the character string, in this case.)

390 : 400 Writes "ｺﾞｳｹｲ".

410 : 420 Writes the total.

430: Returns all character settings to their initial values.

440: END

The total of the data is written in the center of the graph.

The character settings are reset by line 430.

```
1000 DATA ﾄｳｷｮｳ,621,ｶﾝｻｲ,445,ﾄｳﾎｸ,407,ﾁｭｳﾌﾞ,268,ｶﾝﾄｳ,181,ﾎｯｶｲﾄﾞｳ,80,END
```

Data

The item names and the corresponding data are written alternately. "END" is input at the end to indicate the end of data.

- The plotting position of this graph can be altered as required by changing value (1) in line 190.

- This example uses READ and DATA statements, but it is also possible to input the data directly by changing lines 130 and 150 to INPUT statements. In that case, specify a larger value for the array in line 100.

Note: Value (3) in line 190 can range from -32767 to 32767, but note that all the resolutions during plotting will be 0.1° for values of 3600 or more.

6-7-2 Radar chart

This section describes the program for drawing a radar chart.

```
100 E$=CHR$(3)
110 LPRINT"^P2000,1000,900,-7";E$
```

①　②　③

100: Specifies the terminator.

110: Specifies the polar origin.

This program plots a radar chart consisting of 7 items, so the division number (3) is set to 7. It is a negative number because angles are measured positively in the clockwise direction. (2000, 2000) is the polar origin and the +Y direction is set to 0°.

```
120 LPRINT"LP4";E$
130 FOR I=0 TO 6
140 LPRINT"RP";I;1100;0;E$
150 IF I>0 THEN LPRINT"LP1";E$
160 IF I>3 THEN LPRINT"LP7";E$
170 READ A$
180 LPRINT"P";A$;E$
190 NEXT I
```

120: Specifies the position of the first item name. (Center of the character string.)

130: Specifies the angle parameter of polar coordinate command "RP".

140: Draws the coordinate lines of the graph.

150
160: Vary the position of each item name according to the angle of the corresponding coordinate line.

170: Reads in an item name.

180: Writes the item name.

This part of the program draws the graph's coordinate lines and writes the item names.

It draws seven 110-mm (1100) lines from the origin at the set angles.

It then writes each item name starting from a

position specified with respect to the end point of the corresponding line.

```
200 FOR J=0 TO 10
        /
270 NEXT J
```

This draws the scale values and scale lines.

```
210 LPRINT"MP";J*100;"0";E$
220 LPRINT"LP4";E$
230 LPRINT"P";J;E$
```

This writes scale values from 0 to 10 at 10-mm (100) intervals.

210: Specifies the position for each scale value. In this case, the specification is steps of 10 mm (100).

220: Specifies the start point for the writing of the scale values. (The center in this case.)

230: Writes the scale values.

```
240 LPRINT"L4,B50,"
250 LPRINT"MP";100*J;0;E$
260 LPRINT"]";100*J;100*J;900;4500;E$
```

This draws the scale lines.

The type of line is specified by line 240.

240: Specifies the line type of the scale lines. (Input "L0" or erase this line to draw solid lines)

250: Specifies the positions of the scale lines (drawn by the CIRCLE command in this case).

260: Draws the scale lines using the CIRCLE command. The angles are

```
280 LPRINT"L0,B100,"
```

This returns the line type settings to their initial values.

```
290 FOR J=1 TO 3
  /
440 NEXT J
```

This part of the program plots the graph. To add more sub-items, change the values in line 290 and add the data.

```
300 LPRINT"J";J+1
310 READ B
320 B0=B*100
330 LPRINT"MP";B0;0;E$
```

To move to the start point of the graph, the plotter reads in the first data point for each sub-item. Graph specified as 900 to 4500 to make the start and end points the same.

300: Selects the pen to change color for each sub-item.

310: Reads in graph data.

320: Converts the read-in data into actual displacements. (Also specifies the start point of the plotting.)

330: Moves to the start point of the plotting.

data is given as 0 to 10 and so is converted into actual displacements.

```
340 FOR I=1 TO 6
350 READ B
360 LPRINT"DP";B*100;I;E$
370 NEXT I
```

340: This is a loop for reading the remaining data. If sub-items have been added, increase the number of times this loop is repeated to match the number of items added.

350: Reads in data.

360: Draws lines in sequence from the point given by line 330.

This reads in the data, starting from the second data point, and draws lines in turn from the position given by the first data point to be read in.

```
380 LPRINT"DP";B0;0;E$
```

380: Connects the initial and final data points with a line.

To join the start and end points of the plotting, this draws a line from the final data point to the point specified by line 320.

390: Specifies the position of the start of sub-item writing.

```
390 LPRINT"LP2";E$
400 LPRINT"MP1500,1";E$
410 LPRINT"O10";-J*100
420 LPRINT"E100,0";E$
430 LPRINT"P No.";J;E$
```

400
: Move to the sub-item writing
410 position.

420: Draws a sample of a graph line before each sub-item.

430: Writes the sub-items.

This part writes the sub-items automatically in numerical order. To write these by inputting data, see the explanation of data input.

```
450 LPRINT"A"
460 END
```

450: Returns the character settings to their initial values.

460: End

```
1000 DATA SUNDAY,MONDAY,TUESDAY,WEDNESDAY,THURSDAY,FRIDAY,SATURDAY
1010 DATA 9,6,7,3,5,4,8
1020 DATA 7,7,8,6,2,1,5
1030 DATA 5,1,6,4,3,3,10
```

Line 1000 provides the names of the items.

Lines 1010 to 1030 provide graph data for each of the sub-items.

7. DESCRIPTION OF COMMANDS

7-1 How to switch between commands

The MP2300 has three types of commands: built-in personal plotter commands, including many new ones which used to be provided only with more sophisticated models; the original DIGIPLOT (MP1000) commands; and HP-GL emulation commands.

These three types of command can be used simply by setting switches.

The plotter is supplied from the factory set for personal commands, which are superior to the DIGIPLOT commands. In general, the use of these personal plotter commands is recommended.

However, if you already have software for DIGIPLOT commands, it is possible to set the plotter for them, as described in this section.

The method of switching between personal plotter, DIGIPLOT and HP-GL emulation command modes is described below.

• Procedure

Turn the plotter off, then set the change-over switches on its base as shown below.

Change-over switches

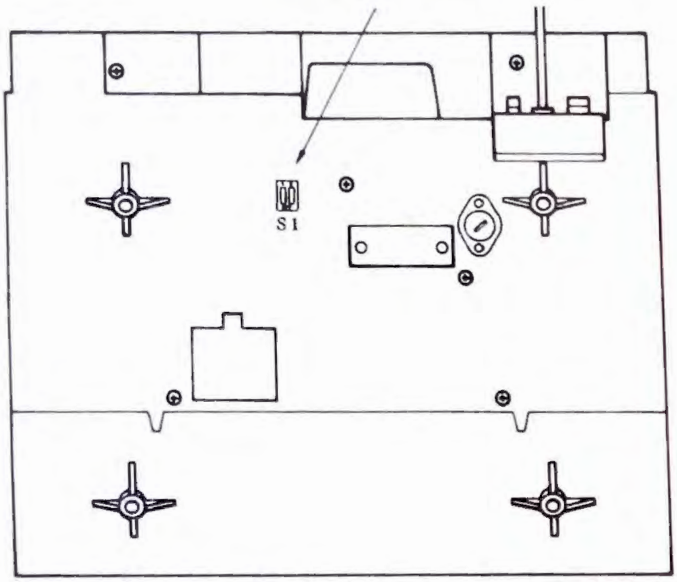


Fig. 7-1-1 Base of MP2300

Change-over switches

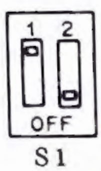


Fig. 7-1-2

These figures show how the plotter is set for personal plotter commands (FP) when bit 2 of S1 is at OFF, and for DIGIPLOT commands (MP) when it is at ON.

For DIGIPLOT (MP1000) commands

For personal plotter (FP5301) commands

For HP-GL emulation commands

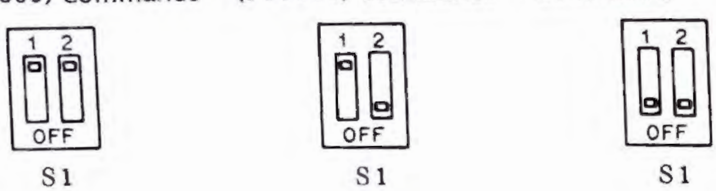


Fig. 7-1-3

7-1-1 Terminology

- HOME position: The origin that is automatically set when the plotter is initialized.

- OFFSET point: A programmed origin which can be set as required by the OFFSET command. It is the same as the HOME position when the plotter is initialized.

- GDU (Graphic Display Unit): The minimum programmable unit. Coordinates are all expressed as integral multiples of this unit. If FACTOR is not activated, the size of a GDU is set at 0.1 mm.

- Plotting area: The area set by specifying LOWER LEFT and UPPER RIGHT. The maximum valid plotting area (400 x 285 mm) is defined as the plotting area when the plotter is initialized.

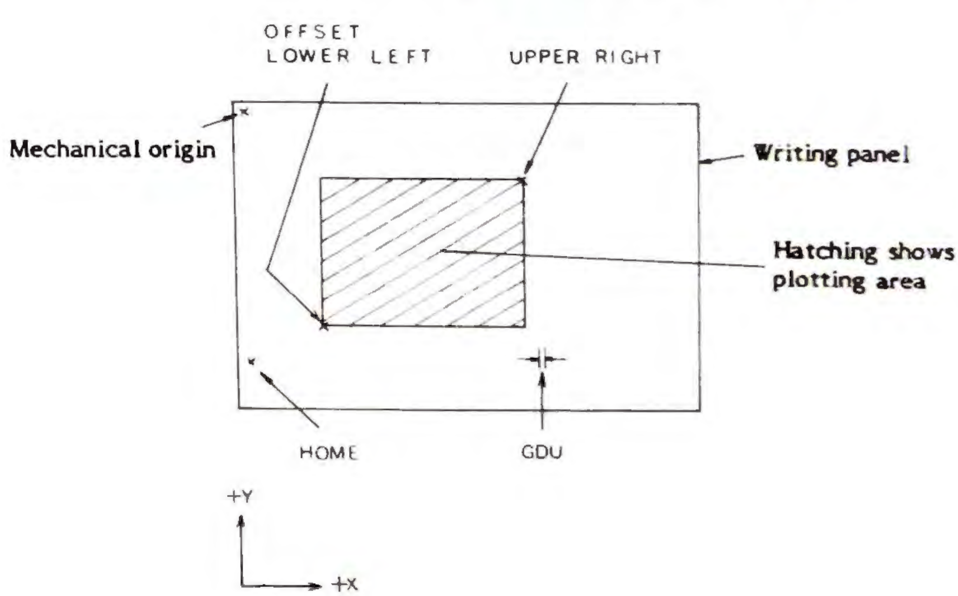


Fig. 7-1-4 Plotting area

- Direct command: A command that is executed immediately it is received by the plotter and is not stored in the buffer memory.
  CLEAR, INTERFACE CLEAR, READ STATUS WORD 1, and READ STATUS WORD 3 are direct commands.

- Command data byte: Expressed as ASCII characters to indicate the kind of command. This must be put at the beginning of each command.
  The command data byte is indicated by uppercase letters in the description of each command in this manual.

- Numerical parameters: These are added as parameters such as coordinates, lengths, or number of times for each command. Parameters are defined as decimal numbers in ASCII characters within the range of -32767 to +32767. There is no limit on the number of digits in a decimal number, provided that it is within this range. However, numbers exceeding 2^{14} (16384) are not permitted for coordinate values. (Note that some commands have limits on the numerical values of their parameters.)
  "+" and "-" signs can be used for decimal numbers. If no sign is specified, the number is handled as a positive number. Decimal points and decimal fractions are not regarded as errors, they are just ignored.
  Numerical values with no integer part, such as .123, or which include an exponent, such as 123E-1, are not permitted. Parameters are indicated by lowercase letters in the descriptions of the commands in this manual.

Correct examples 3450, -345, +345

Character parameters: Character codes which are added to commands as data for the writing of characters, and which are specified as ASCII characters, or JIS 7-bit or 8-bit codes. (See the code charts at the end of this manual for details.)

Examples	"A"	"1"	"ア"
	$(41)_{16}$	$(31)_{16}$	$(B1)_{16}$ or SO $(31)_{16}$

. Delimiter: Always put a delimiter at the end of each numerical parameter to punctuate it. However, in commands like DRAW, RELATIVE DRAW, USER'S PATTERN, CURVE and RELATIVE CURVE, which have a variable number of parameters, it is necessary to put a terminator after the last parameter.

The following can be used as delimiter:

- SP (space)
- CR (carriage return)
- LF (line feed)
- , (comma)
- + (plus sign)
- - (minus sign)

In the descriptions of the commands in this manual, commas are used as delimiters.

. Terminator: Indicates the end of a command which has a variable number of parameters (numerical or character). In the initial setting, ETX (the End-of-Text code, 03H) is the terminator.

If the ETX code is not received at the end of a command like PRINT, the next command to be

received will also be handled as character parameters and written out as characters.

In standard BASIC, the terminator is defined as CHR$(3), but CR (Carriage Return), LF (Line Feed), etc., can also be specified as terminator by the TERM command.

Sending another terminator when all the previous commands have ended has no effect.

D	DRAW command: Straight line drawing

Command symbol D (uppercase letter)

Function Draws a straight line in the absolute coordinate system, with the pen down.

Input format D x_1, y_1, x_2, y_2, ... x_n, y_n (terminator)

Statement example LPRINT "D 1000, 1000, 1500,2000"; CHR$(3)

Parameter range $-16383 \leq x_i, y_i \leq 16383$

Related commands L, B

Description This command draws straight lines, starting from the current pen position (x_0, y_0) and connecting in succession the coordinates specified by (x_1, y_1), (x_2, y_2), ... (x_n, y_n).

Express all the coordinates as absolute coordinates. Parameters are valid within the range of -16383 to +16383; decimal points and decimal fractions are truncated.

Any parameter which exceeds this range, or which is not paired with another to give (x, y) coordinates, is handled as an error.

If a specified pair of coordinates is outside the valid plotting area, the pen draws the line up to the edge of the valid plotting area, then rises.

Example LPRINT"D 500,500,-500,1000,-500,
2000,2000,2500"; CHR$(3)

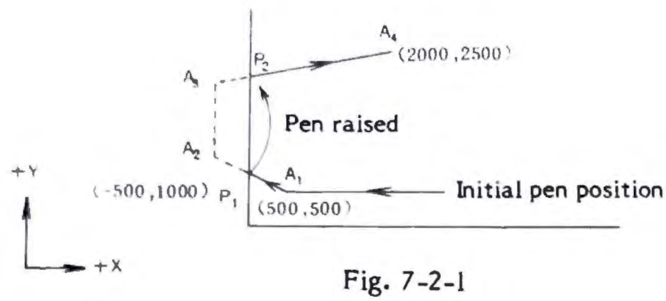


Fig. 7-2-1

If lines connecting A1 - A2 - A3 - A4 are specified, but A2 and A3 happen to be outside the valid plotting area, as shown above, the pen moves along A1 - P1 -P2 - A4 without drawing a line from P1 - P2.

E	RELATIVE DRAW command:	Straight line drawing between relative coordinates

Command symbol E (uppercase letter)

Function Draws a straight line in the relative coordinate system from the current pen position, with the pen down.

Input format $E \triangle x_1, \triangle y_1, \triangle x_2, \triangle y_2, \cdots\cdots, \triangle x_n, \triangle y_n$ (terminator)

Statement example LPRINT "E1000,1000";CHR$(3)

Parameter range $-16383 \leqq \triangle x_i, \triangle y_i \leqq 16383$

Related commands L, B

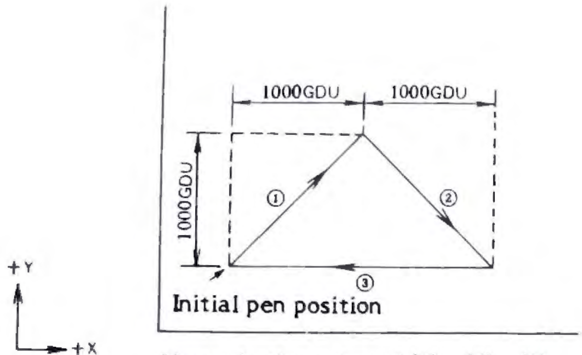
Description This command draws a straight line to the coordinates specified by the displacements $\triangle x$, $\triangle y$ from the current pen position (x_0, y_0). To connect several coordinates in succession, specify each coordinate point as displacements ($\triangle x$, $\triangle y$) from the end of the previous line segment. Express all coordinates as relative coordinates.

Parameters are valid within the range of -16383 to +16383; decimal points and decimal fractions are truncated.

Any parameter which exceeds this range, or which is not paired with another to give (x, y) coordinates, is handled as an error.

If a specified pair of coordinates is outside the valid plotting area, the pen draws the line up to the edge of the plotting area, then rises.

Example LPRINT"E 1000,1000,1000,−1000, −2000,0" ; CHR $(3)



Moves in the order of (1) - (2) - (3)

Fig. 7-2-2

M	MOVE command: Movement of raised pen

Command symbol	M (uppercase letter)
Function	Moves the raised pen in the absolute coordinate system.
Input format	M x , y ,
Statement example	LPRINT "M1000, 1000, "
Parameter range	$-16383 \leqq x, y \leqq 16383$

Description

This command moves the raised pen from its current position (x_0, y_0) to the specified coordinates (x, y).

Express all the coordinates as absolute coordinates. Parameters are valid within the range of -16383 to +16383; decimal points and decimal fractions are truncated.

If a series of MOVE commands is input, the pen does not move to each point, only to the point determined to be the final point by the succession of MOVEs.

This command is mainly used for moving the pen to the start of straight lines and characters.

If a specified pair of coordinates is outside the valid plotting area, the pen stops at the edge of the plotting area.

Example LPRINT"M 500,600,"

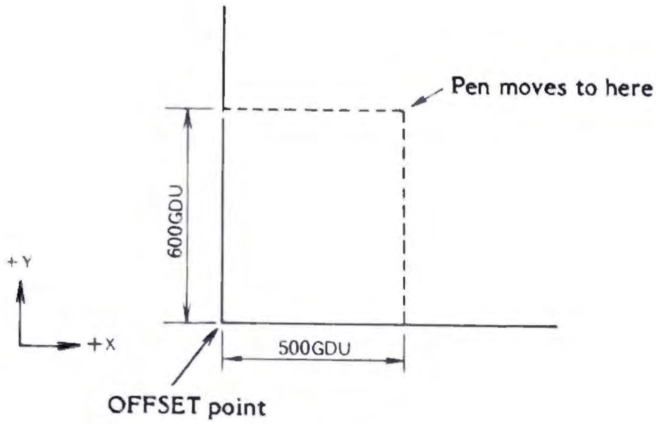


Fig. 7-2-3

O	RELATIVE MOVE command:	Movement of raised pen between relative coordinates

Command symbol	O (uppercase letter)
Function	Moves the raised pen in the relative coordinate system.
Input format	O△x , △y ,
Statement example	LPRINT "O 1000, 1000, "
Parameter range	$-16383 \leqq \triangle x, \triangle y \leqq 16383$

Description

This command moves the raised pen to the coordinates specified by the displacements ($\triangle x$, $\triangle y$) from the current pen position (x_0, y_0).

Express all coordinates as relative coordinates. Parameters are effective within the range of -16383 to +16383; decimal points and decimal fractions are truncated.

If a series of RELATIVE MOVE commands is given, the pen does not move to each point, it moves directly to the final point determined by the succession of RELATIVE MOVEs (to the point obtained by summing the displacements).

If a specified pair of coordinates is outside the valid plotting area, the pen stops at the edge of the plotting area.

Example LPRINT"O100,100,"

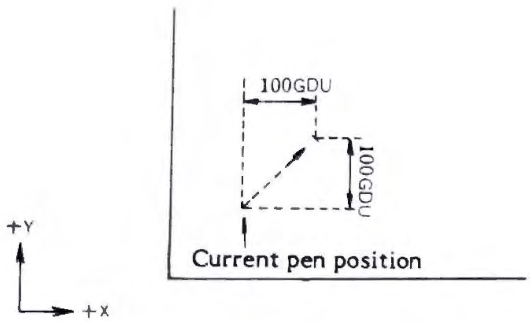


Fig. 7-2-4

P	PRINT command	Character writing
K	KANA (Greek) command	

Command symbols PRINT P
KANA K

Function Write ASCII, katakana, or Greek characters

Input formats
PRINT $P\, c_1, c_2 \cdots\cdots c_n$ (terminator)
KANA $K\, c_1, c_2 \cdots\cdots c_n$ (terminator)

Statement examples
LPRINT "PABCD" ; CHR$(3)
LPRINT "Kアイウエ" ; CHR$(3)

Parameter definition C $10_{(H)} \sim 7E_{(H)}$
$90_{(H)} \sim FE_{(H)}$

Related commands (, S , Q , R , I , A , SP , LP

Description

These commands write the ASCII, katakana, and Greek characters which are given as parameters. Use ASCII and JIS 8-bit codes for these parameters.

The characters written by these commands differ according to which FONT command is given, see the code charts at the end of this manual for details.

Writing starts from the lower left of the first character, and the size (ALPHA SCALE), spacing (ALPHA SPACE), rotation (ALPHA ROTATE) and slope (ALPHA ITALIC) of the characters are those specified immediately beforehand. Any respecification of these factors must come before the "P" and "K" commands.

The "P" command and the "K" command can be regarded as the same command with different entrances. The "P" command is initially set on the shift-in (SI) code $(0F)_{10}$ side, and the "K" command on the shift-out (SO) code $(0E)_{10}$ side. This means that if an SO code is input while a "P" command is being executed, the character written next will be a katakana character. If a SI code is input, the character written next will be an alphanumeric. When JIS 8-bit code is used, katakana characters are written when B8 = 1 and alphanumerics when B8 =0, so that a mixture of alphanumeric, katakana, and Greek characters is possible during a "P" command. The same is true for a "K" command, but when the system is set to the SO code side, B8 is always handled as 1 and has no effect.

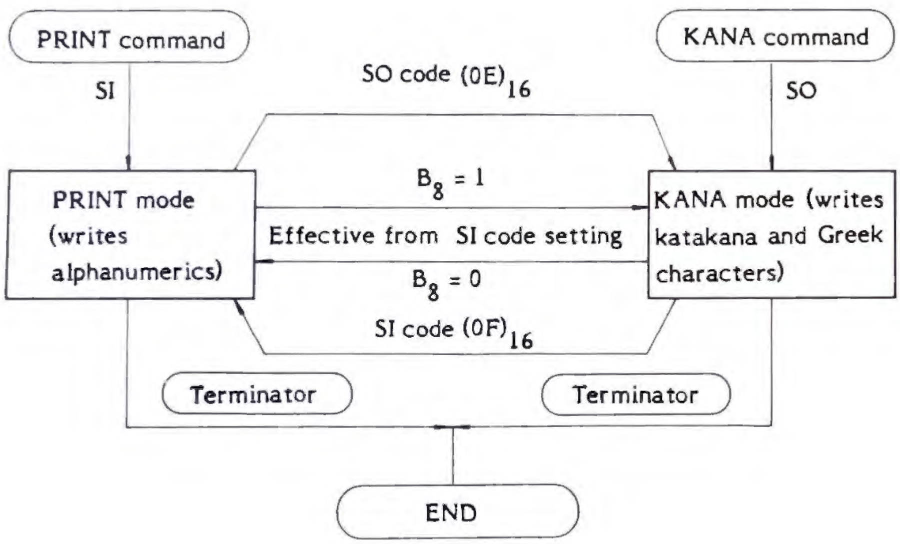


Fig. 7-3-1 Change-over between PRINT and KANA modes

Note: Some alphanumerics and Greek characters extend further downward then others (see the character pattern charts). If those characters are written along the lower border of the valid plotting area, the parts that extend outside the plotting area will be omitted.

Handling of special codes

BS (08H) (Back Space)	The pen back-spaces one character, in the scale and orientation currently specified.
CR (0DH) (Carriage Return)	The pen moves to the lower left corner of the first character in the current line.
LF (0AH) (Line Feed)	The pen position moves down by the specified line spacing, which is 1.5 times the character height set by the ALPHA SCALE command.

Example 1 LPRINT"PABCｱｲｳ" ; CHR$(3)

→ABCアイウ

Example 2 LPRINT"K123ｱｲｳ" ; CHR$(3)

→アイウアイウ

Example 3 LPRINT"PABC" ;CHR$ (14) ;"123" ;CHR$(3)

→ABCアイウ

Note: CHR(14) is the shift-out (SO) code in BASIC.

Example 4 LPRINT"PABC";CHR$(13);CHR$(10);
"DEF";CHR$(3)

→ ABC
DEF

Note: CHR$(13);CHR$(10) are the carriage return and line feed (CR, LF) codes in BASIC.

Table 7-3-1 Character pattern chart (1/4)

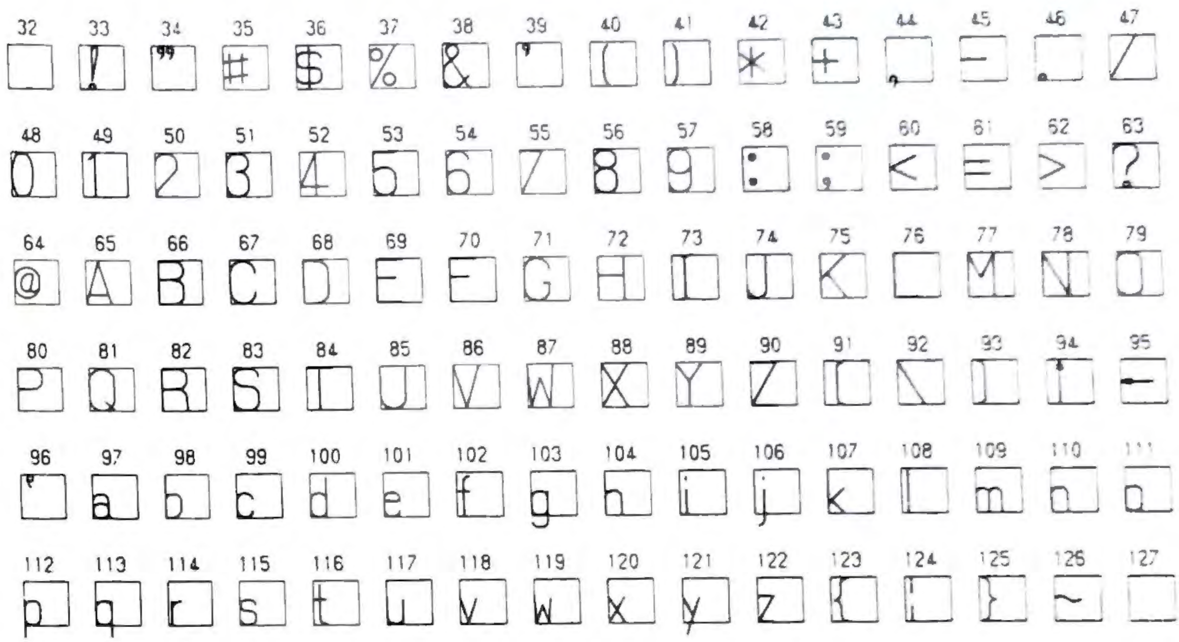
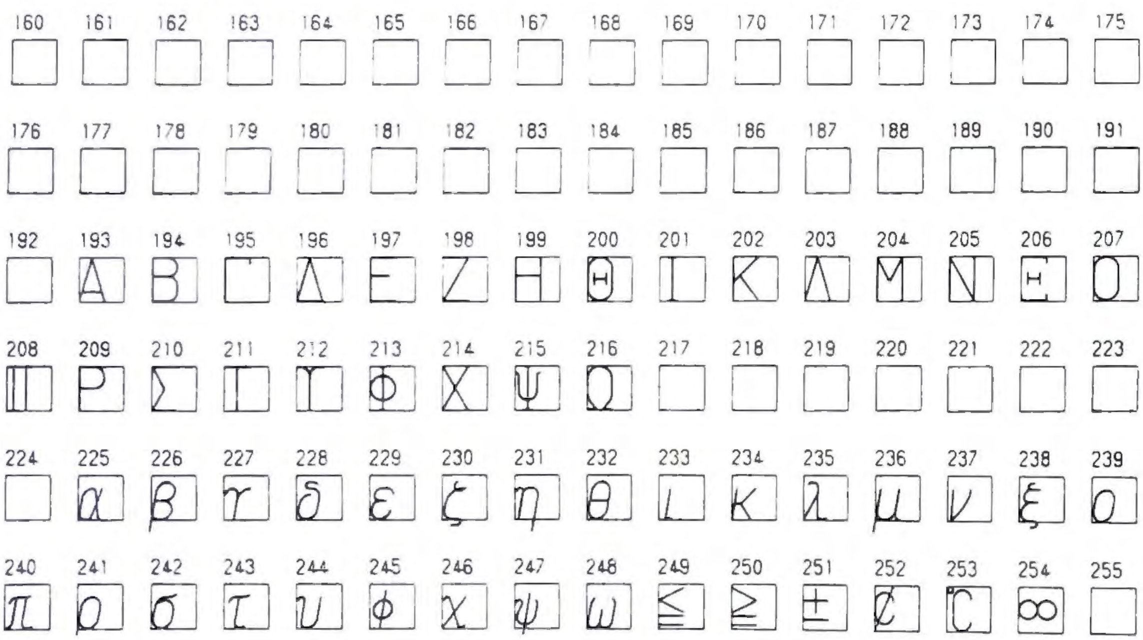


Table 7-3-2 Character pattern chart (2/4)

Table 7-3-3 Character pattern chart (3/4)

Note: Character patterns for these codes depend on the FONT command.

Table 7-3-4 Character pattern chart (4/4: when FONT$10, is specified)



N MARK command: Symbol drawing

Command symbol N

Function Draws the symbol specified by parameter n, centered on the current pen position.

Input format Nn ,

Statement example LPRINT "N3"

Parameter range $0 \leq n \leq 15$

Related commands S , R , I

Description This command draws the symbol specified by parameter n, centered on the current pen position.

Parameter n is an integer from 0 to 15, corresponding to one of the symbols below. The pen returns to its initial position after drawing the symbol.

n = 0 Draws nothing.

n = 1 to 15 Draws the corresponding symbol in the size, orientation, and slope specified immediately before by the S, R and I commands.

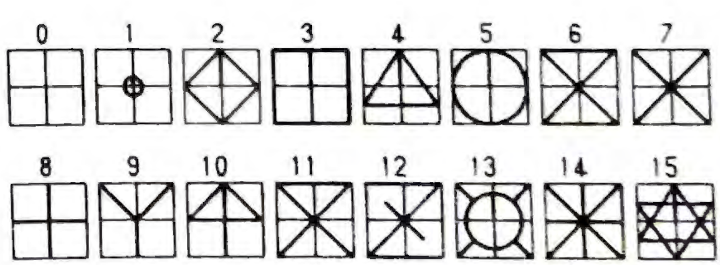


Fig. 7-3-2 Symbol patterns

(P	USER'S PROGRAM PATTERN command:	Construction of used-defined characters

Command symbol (P

Function Constructs characters or symbols which are not in the character code charts.

Input format (P $[p,]\Delta x_1, \Delta y_1, [p,]\Delta x_2, \Delta y_2, \cdots\cdots [p,]\Delta x_n, y_n$ (terminator)

Statement example

```
LPRINT "(P0,14,99,8,0,-99,-6,0,99,0,-14,-99,2,14
        99,0,-14,-99,2,14,99,0,-14,-99,-6,0,99,8,
        0";CHR$(3)
```

This draws the pattern "III", starting from the current pen position.

Parameter definitions p: Pen control parameter. Specifies pen up or down.

$p \geqq 99$: Pen down

$p \leqq -99$: Pen up

$\triangle x$, $\triangle y$: Displacements on a grid for pattern definition. Integers from -98 to +98.

Parameter ranges

$-98 \leqq \Delta x \leqq 98$ $p \leqq -99$, $p \geqq 99$

$-98 \leqq \Delta y \leqq 98$

$-127 \leqq \Delta x_1 + \Delta x_2 + \cdots\cdots + \Delta x_n \leqq 127$

$-127 \leqq \Delta y_1 + \Delta y_2 + \cdots\cdots + \Delta y_n \leqq 127$

Related commands S , Q , R , I , A

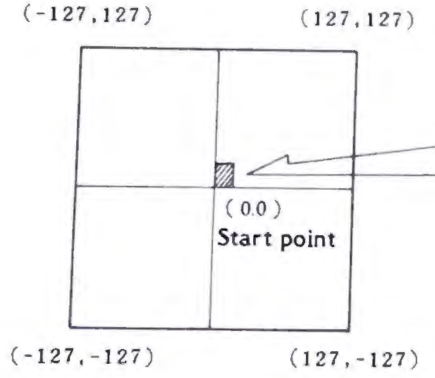
Description This command enables you to draw characters, symbols, etc., which are not in the character code charts, by defining each as a pattern on a grid of up to 254 x 254 points, using the pen control value p

(pen up/down specification) and displacements $\triangle x$, $\triangle y$.

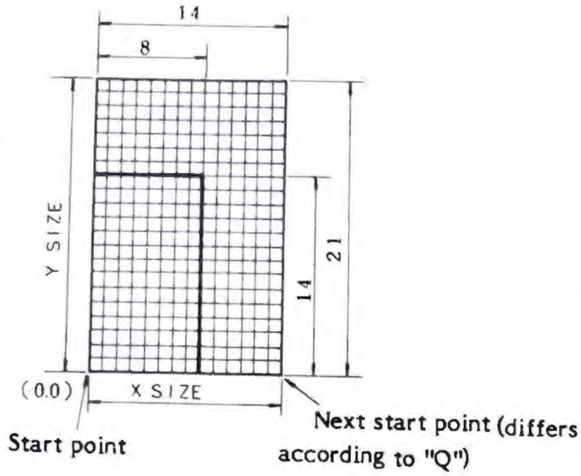
Parameter p indicates whether the pen should be up or down; the pen is up when p is -99 or less and down when p is 99 or more. If one of these statuses is specified, it remains valid until it is respecified, so there is no need to specify the pen status for each pen movement. When this command is received, however, the plotter always raises the pen, so pen-down must be specified once before drawing the constructed pattern. (When this command is complete, the pen returns to the status it had before the command was received.)

$\triangle x$, $\triangle y$ specify the horizontal and vertical displacements of the pen, using grid points. Any values within the range of -98 to 98 can be specified. Decimal points and decimal fractions are ignored.

The grid used for specifying the pen displacements is shown below.



Grid range that can be defined by the "(P" command.



Grid size for standard characters

Fig. 7-3-3

You can construct characters, symbols, etc., by defining patterns within a grid expressed by coordinates from -127 to 127, with the start point of the drawing being considered the origin (0, 0). (See the figure above.) $\triangle x$ and $\triangle y$ cannot go farther from the origin than the range of -127 to 127. The start point in this case is the point to which the pen moves when the "(P" command is input; this becomes the origin. The point at which the pen actually comes down and starts to draw can be specified freely, provided it is a point on the grid.

The grid for standard characters is 14 x 21 in the initial setting, but in fact each character is

constructed on an 8 x 14 grid in the lower left corner of the 14 x 21 grid, with the lower left corner acting as origin. The remaining area provides spacing with respect to the adjacent characters.

This standardization of the size of patterns made using the "(P" command onto the same 8 x 14 grid means that they can be drawn at the same size.

The distance the pen moves after writing a character (that is, the distance to the start point of the next character) is fixed at one character equivalent, as shown in Fig. 7-3-4, unless otherwise specified by the "Q" command. This means that if patterns have been constructed on a larger grid, the characters will overlap unless the pen is moved by a command.

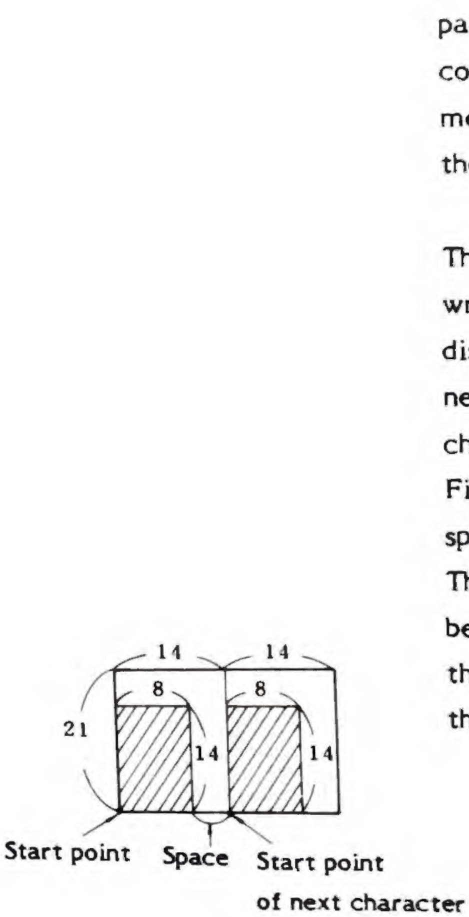
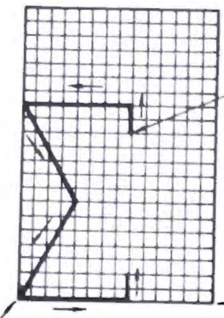


Fig. 7-3-4 Relationship between characters in initial setting

Example



LPRINT " (P 8 , 12 , 99 , 0 , 2 , -8 , 0 , 4 , -7 , -4 , -7 , 8 , 0 , 0 , 2 " ; CHR $(3)

Start point

* S, Q are at their initial settings.

Character origin

Pen moves to here after drawing the pattern (start point of next character).

Fig. 7-3-5

W	CIRCLE command: Drawing of circle, arc, or spiral

Command symbol W (uppercase letter)

Function Draws a circle, arc, or spiral.

Input format W x_0, y_0, r_1, r_2, θ_1, θ_2 [, d] (terminator)

Statement example LPRINT "W 1000, 1000, 500, 500, 0, 3600" ; CHR$(3)

This draws a circle of radius 500 units, centered on (1000, 1000).

Parameter definitions

x_0, y_0:	Coordinates of center
r_1, r_2:	Initial and final radii (integral multiples of GDU)
θ_1, θ_2:	Initial and final angle (integral multiples of 0.1°)
d:	When d > 0, d gives the angle subtended by segments of the circle (d = 100 gives 10° segments) When d < 0, d gives the number of segments of the circle (d = -5 divides the circle into 5) When d = 0, automatic division is provided.

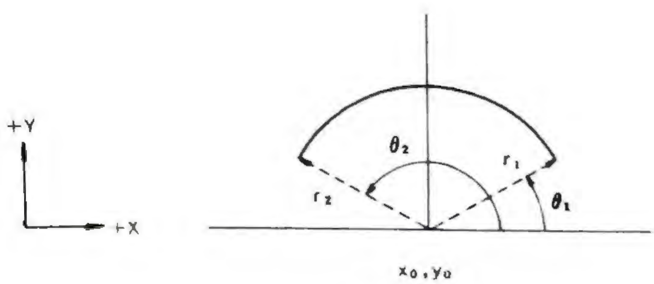


Fig. 7-4-1

Parameter ranges

$-16383 \leqq x_0, y_0, r_1, r_2 \leqq 16383$

$-32767 \leqq \theta_1, \theta_2, \theta_1 - \theta_2 \leqq 32767$

$-16383 \leqq d \leqq 16383$

Related commands

L, B

Description

This command draws a circle, arc, or spiral of the radii specified by the parameters r_1, r_2, centered on the coordinates specified by x_0, y_0. To draw a circle, specify $r_1 = r_2$, $\theta_1 = 0$, and $\theta_2 = 3600$. A spiral can be drawn by making the values of r_1 and r_2 different.

The drawing is counterclockwise when $\theta_1 < \theta_2$ and clockwise when $\theta_1 < \theta_2$. Angles are measured positively in the counterclockwise direction and negatively in the clockwise direction, from the X-axis.

A polygon can be drawn by specifying the parameter d. This can be done in two different ways, depending on whether d is a positive or negative number.

When d is a positive number, it specifies the angle subtended by segments. For example, d = 600 (60^o) draws a hexagon.

When d is a negative number, it specifies the number of segments of the circumference of the circle. For example, d = -6 divides the circumference into six, to draw a hexagon.

The parameter d can be omitted. When it is omitted, a segment angle that provides a smooth circle is automatically selected.

Example 1

To divide the circumference of a circle into 6

```
LPRINT"W 1000,1000,200,200,0,3600,-6";CHR$(3)
```

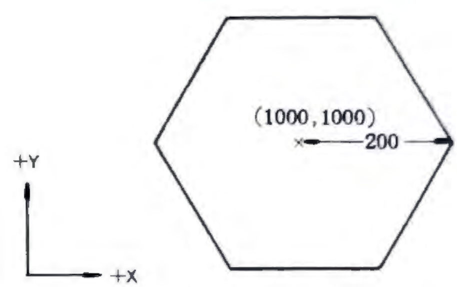


Fig. 7-4-2

Example 2

To draw a spiral

```
LPRINT "W 1000,1000,200,0,7200" ; CHR$(3)
```

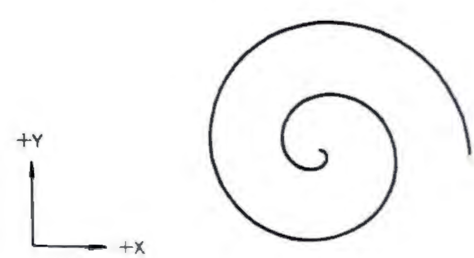


Fig. 7-4-3

]	RELATIVE CIRCLE command:	Drawing of circle, arc, or spiral from current pen position

Command symbol]

Function — Draws a circle, arc, or spiral, starting from the current pen position.

Input format —] r_1, r_2, θ_1, θ_2 [, d] (terminator)

Statement example — `LPRINT " ]500,500,0,3600 "; CHR$(3)`

This draws a circle of radius 500 units, starting from the current pen position.

Parameter definitions

r_1, r_2: Initial and final radii (integral multiples of GDU)

θ_1, θ_2: Initial and final angle (integral multiples of 0.1°)

d: When d $>$ 0, d gives the angle subtended by segments of the circle (d = 100 gives 10° segments)

When d $<$ 0, d gives the number of segments of the circle (d = -5 divides the circle into 5)

When d = 0, automatic division is provided.

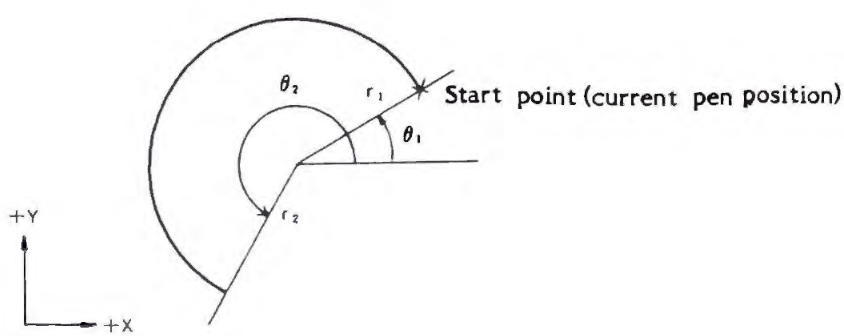


Fig. 7-4-4

Parameter ranges

$-16383 \leqq r_1, r_2 \leqq 16383$

$-32767 \leqq \theta_1, \theta_2, \theta_1 - \theta_2 \leqq 32767$

$-16383 \leqq d \leqq 16383$

Related commands

L, B.

Description

This command draws a circle, arc, or spiral, starting from the current pen position. To draw a circle, specify the parameters $r_1 = r_2$, $\theta_1 = 0$ and $\theta_2 = 3600$. A spiral can be drawn by making the values of r_1 and r_2 different.

The drawing is counterclockwise when $\theta_1 < \theta_2$, and clockwise when $\theta_1 > \theta_2$. Angles are measured positively in the counterclockwise direction and negatively in the clockwise direction, from the X-axis.

A polygon can be drawn by specifying the parameter d. This can be done in either of two ways, depending on whether d is a positive or a negative number.

When d is a positive number, it specifies the angle subtended by segments. For example, d = 600 (60°) draws a hexagon.

When d is a negative number, it specifies the number of segments of the circumference of the circle. For example, d = -6 divides the circumference into six, to draw a hexagon.

The parameter d can be omitted. When it is omitted, a segment angle which provides a smooth circle is automatically selected.

A terminator is necessary for this command.

Example To draw a spiral

```
LPRINT"]200,0,0,7200,-20";CHR$(3)
```

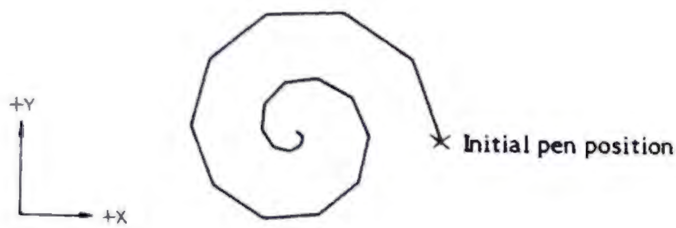


Fig. 7-4-5

Y	CURVE command: Curve drawing

Command symbol: Y

Function: Draws a curve through a string of absolute coordinates.

Input format: Y a, x_1, y_1, x_2, y_2, ... x_n, y_n (terminator)

Statement example: LPRINT "Y1,500,500,500,750,1000,500,1000,750";CHR$(3)

Parameter definitions:

a = 0: Open curve

a = 1: Closed curve

x_1, y_1: Start point of curve

x_2, y_2 .... x_n, y_n:
Consecutive coordinates of the curve

Parameter ranges:

$0 \leqq a \leqq 1$

$-16383 \leqq x_n, y_n \leqq 16383$

Related commands: L, B

Description:

This command draws a smooth cubic curve through points x_n, y_n given as absolute coordinates. Two types of curve can be selected by parameter a, an open curve is drawn when a = 0, and a closed curve when a = 1.

At least three data points are necessary in this command. Do not specify the same point twice in succession in the data, and try to keep each distance between adjacent data points as close to the same value as possible.

For a closed curve, it is not necessary to specify the start point again as the end point. The actual start point and end point of the curve is the second point defined.

The pen moves raised as far as the start point of the curve.

A terminator is necessary at the end of the data.

Example

```
LPRINT"Y0,500,500,700,600,1100,400,1300,500";CHR$(3)
```

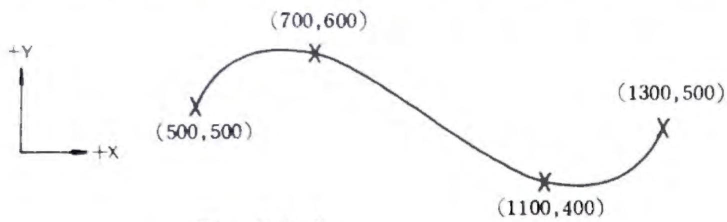


Fig. 7-4-6

←	RELATIVE CURVE command:	Curve drawing in relative coordinate system

Command symbol ← ("_" in JIS code)

Function Draws a curve through a string of relative coordinates.

Input format ←a, $\triangle x_1$, $\triangle y_1$, $\triangle x_2$, $\triangle y_2$, ... $\triangle x_n$, $\triangle y_n$ (terminator)

Command example LPRINT "←1,500,500,0,250,500,-250,0250";CHR$(3)

Parameter definitions
a = 0: Open curve
a = 1: Closed curve
$\triangle x_1, \triangle y_1$: Relative displacements from the current pen position to the start point of the curve
$\triangle x_2, \triangle y_2$ ...... $\triangle x_n, \triangle y_n$: Relative displacements of successive points

Parameter ranges
$0 \leqq a \leqq 1$
$-16383 \leqq \triangle x_n, \triangle y_n \leqq 16383$

Related commands L, B

Description This command draws a smooth cubic curve through points whose coordinates are given by successive relative displacements with respect to the current pen position. Two types of curve can be selected by parameter a, an open curve is drawn when a = 0, and a closed curve when a = 1.

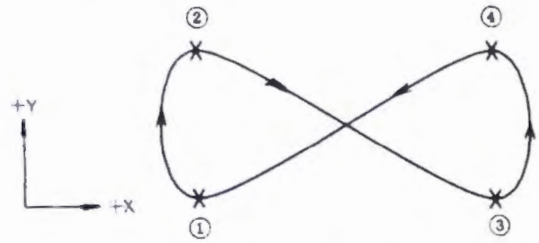
At least three data points are necessary for this command. Do not specify the same point twice in succession in the data, and try to keep each distance between adjacent data points as close to the same value as possible.

For a closed curve, it is not necessary to specify the start point again as the end point. The actual start point and end point of the closed curve is the second point defined.

A terminator is necessary at the end of the data.

Example

```
LPRINT" ← 1,100,100,0,250,500,-250,0,250" ;CHR$(3)
```



The curve is drawn in the sequence (2) - (3) - (4) - (1) - (2).

Fig. 7-4-7

)	ELLIPSE command: Ellipse drawing

Command symbol)

Function Draws an ellipse.

Input format) a, x_0, y_0, r_1, r_2, θ_1, θ_2, θ_3.

Statement example `LPRINT ")0,1000,1000,500,250,0,3600,450."`

Parameter definitions

a = 0: Moves the raised pen from the current pen position to the start point of the ellipse.

a = 1: Moves the lowered pen from the current pen position to the start point of the ellipse.

x_0, y_0: Coordinates of the center of the ellipse

r_1: Radius of major axis (integral multiple of GDU)

r_2: Radius of minor axis (integral multiple of GDU)

θ_1, θ_2: Initial and final angles

θ_3: Angle between major axis and X-axis

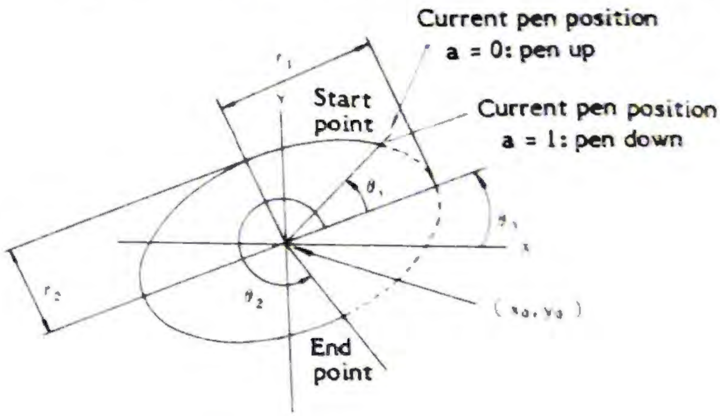


Fig. 7-4-8

Parameter ranges

$-16383 \leq x_0, y_0 \leq 16383$

$-16383 \leq r_1 \leq 16383$ $\qquad r_2 < r_1$

$-16383 \leq r_2 \leq 16383$

$-3600 \leq \theta_1, \theta_2, \theta_1 - \theta_2 \leq 3600$

$-3600 \leq \theta_3 \leq 3600$

Description

This command draws an ellipse whose major axis is r_1 and minor axis r_2, centered on the coordinates (x_0, y_0).

The inclination of the major axis of the ellipse to the X-axis can be specified by θ_3 when $\theta_1 - \theta_2 = 3600$.

L	LINE TYPE command: Line type specification

Command symbol	L	(uppercase letter)
Function	Specifies the type of line.	
Input format	L p ,	
Statement example	LPRINT "L2,"	
Parameter range	$0 \leq p \leq 8$	Initial setting is p = 0
Related commands	D , E , DT , ET , W , Y , ← ,)	

Description

This command specifies the type of line, which can be selected from the following 9 types.

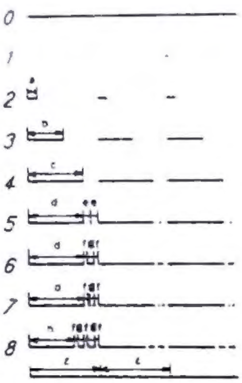
Commands relating to characters and axes are not affected by this command, i.e., K, P, (, N, (P, X, %).

The initial setting is p = 0 (solid line). If nothing else is specified, solid lines are drawn. If a parameter other than 0 to 8 is specified, it is ignored and the previously-set value remains valid.

Once a parameter is set, the line type selected by it remains valid until it is respecified or the plotter is initialized.

* Parameter ℓ in the following examples is specified by the LINE SCALE command "B". Do not specify p = 1, 5 or 7 when using ball-point pens.

Solid line	$P=0$
Dots at regular intervals	$P=1$
1/8 of the pitch is a solid line	$P=2$
1/2 of the pitch is a solid line	$P=3$
25/32 of the pitch is a solid line	$P=4$
Dot-dash line	$P=5$
Long-short dashed line	$P=6$
Double-dot-dash line	$P=7$
Long-short-short dashed line	$P=8$



$$a=\frac{1}{8}\ell,\ b=\frac{1}{2}\ell,\ c=\frac{25}{32}\ell,\ d=\frac{25}{32}\ell,\ e=\frac{7}{64}\ell,\ f=\frac{5}{64}\ell,\ g=\frac{4}{64}\ell,\ h=\frac{41}{64}\ell$$

Fig. 7-5-1

B	LINE SCALE command: Specification of pitch of broken lines

Command symbol B (uppercase letter)

Function Specifies the pitch of broken lines.

Bℓ,

Statement example LPRINT " B 80,"

Parameter range $0 \leqq \ell \leqq 16383$ Initial setting is ℓ = 100

Related command L

Description This command specifies the pitch of the broken or dotted lines specified by the LINE TYPE command "L". Integers within the range of 0 to 16383 are valid as the parameter. When the parameter is specified so that it is larger than the length of a line to be drawn, the plotter draws a solid line.

The initial setting is ℓ = 100.

Once the pitch is set by this command, it remains valid until it is respecified (by a "B" command) or the plotter is initialized.

Fig. 7-5-2

S	ALPHA SCALE command:	Specification of character and symbol sizes

Command symbol　S

Function　Specifies the size of characters and symbols (marks).

Input format　S n , [m ,]

Statement example　LPRINT "S 40,"

Parameter definitions
n: Height (integral multiple of GDU)
m: Width (integral multiple of GDU)

Fig. 7-5-3

Parameter ranges
$0 \leqq n \leqq 8000$
$0 \leqq m \leqq 8000$　Initial setting is n = m = 30

Related commands　P , K , N , (P , (

Description

This command specifies the height (n) and width (m) of the characters as integral multiples of the GDU. m can be omitted. When it is omitted, m = n is assumed.

This initial setting is n = m = 30, where m is the width including a space.

When a character size is set by this command, it remains valid until it is respecified or the plotter is initialized.

This command influences the commands "K", "P", "(", "(P" and "N".

Example

```
LPRINT"S100,200,Q220,PABC";CHR$(3)
```

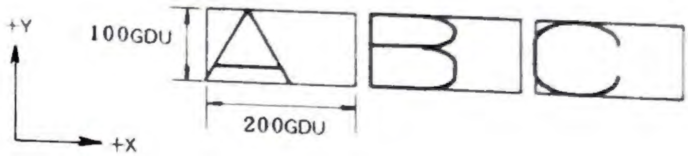


Fig. 7-5-4

Q	ALPHA SPACE command: Specification of character spacing

Command symbol Q

Function Specifies the spacing between the start point of one character and the start point of the next character.

Input format Qℓ, [k,]

Statement example LPRINT "Q40,"

Parameter definitions

ℓ: Displacement in X-axis direction (measured positively in the +X direction)

k: Displacement in Y-axis direction (measured positively in the +Y direction)

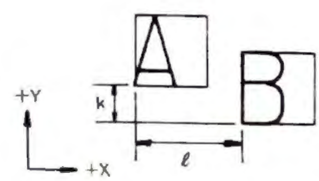


Fig. 7-5-5

Parameter ranges

$-8000 \leq \ell \leq 8000$ (Integral multiple of GDU)

$-8000 \leq k \leq 8000$ (Integral multiple of GDU)

Initial setting is $\ell = 30$, $k = 0$

Related commands P, K, N, (P, (

Description This command specifies the spacing between the start point of one character and that of the next along the X- and Y-axes, as integral multiples of the GDU.

If the ALPHA ROTATE command "R" is not specified, parameter ℓ means the displacement in

the X-axis direction, and parameter k the displacement in the Y-axis direction.

Note that when an "R" command is issued, the directions of ℓ and k rotate together with the characters.

The ALPHA SPACE command can be used as a simple way of writing characters vertically. For vertical writing, just specify ℓ as 0 and k as a negative number.

Parameter k can be omitted; it is handled as 0 when omitted.

This command affects all the character commands: "K", "P", "(", "(P" and "N".

Example

```
LPRINT"S100,Q0,-120,PAB";CHR$(3)
```

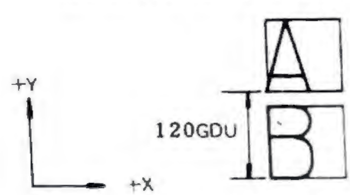


Fig. 7-5-6

R	ALPHA ROTATE command: Rotation of characters

Command symbol R

Function Rotates the orientation of characters and character strings.

Input format Rθ

Statement example LPRINT"R300,"

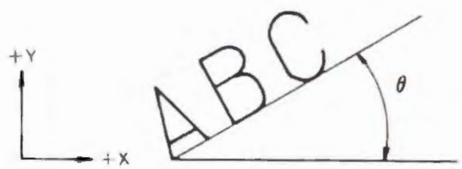


Fig. 7-5-7

Parameter range $-32767 \leq \theta \leq 32767$ Measured positively in the counterclockwise direction
Initial setting is $\theta = 0$.

Related commands P,K,N,(P,(

Description Use this command to rotate characters and character strings.

Parameter θ gives the angle of rotation as an integral multiple of 0.1°. It is valid within the range of -32767 to 32767; any decimal point and decimal part are truncated.

The angle of rotation is measured positively in the counterclockwise direction and negatively in the clockwise direction, with respect to the X-axis. If not otherwise specified, it is set at 0°.

I | ALPHA ITALIC command: Tilting of characters

Command symbol I

Function Specifies the slope of characters and symbols.

Input format I p ,

Statement example LPRINT "I256,PAB"

Parameter range $-4000 \leqq p \leqq 4000$

$p = 256 \tan \theta$

Related commands P , K , (, (P , N ,

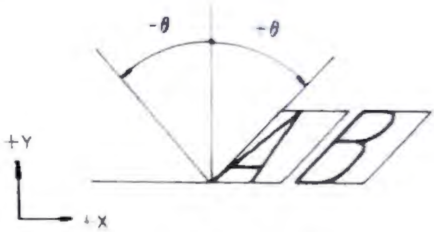


Fig. 7-5-8

Description

Use this command to draw sloping characters. Unlike the parameters of other commands which specify rotational angles, the parameter of this command is expressed by:

$$p = 256 \tan \theta$$

θ represents the angle of slope of the character with respect to the Y-axis, positively in the clockwise direction and negatively in the counterclockwise direction. Once you decide on the angle of slope of the characters, substitute it into the equation to get the value of parameter p.

For example, to tilt the characters at $+45^{\circ}$ to the Y-axis:

$$\begin{aligned} p &= 256 \tan(45^{\circ}) \\ &= 256 * 1 \\ &= 256 \end{aligned}$$

Therefore parameter p is 256.

* Any decimal point and decimal fraction in the value of p are truncated.

Example

```
LPRINT"I";256*TAN(10*3.1415926/180)
LPRINT"PABC";CHR$(3)
```

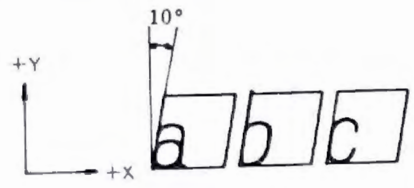


Fig. 7-5-9

$	FONT command: Character code selection

Command symbol	$
Function	Selects the code chart for the characters, and sets the resolution of the character patterns to be drawn by "P" and "K" commands.
Input format	$n, [m,]
Statement example	LPRINT "$0,2," This selects the STANDARD character codes, and sets the resolution of the curved parts of the characters to twice the initial value.
Parameter ranges	n 0 ~ 99 (See the description for the meaning of each value) Initial setting is n = 60 m 2^K (K = 0 ~ 5) (See the description for the meaning of each value) Initial setting is m = 4

Description

Parameter m of this command selects the code chart for the characters to be written by the "P" and "K" commands. (See the code charts at the end of this manual.)

Table 7-5-1 shows the 12 special characters that can be selected to provide fonts for different countries, by specifying the corresponding value as parameter n.

The writing of katakana characters can be selected, and five different character patterns for 0 (zero) and O (oh) can also be selected.

Table 7-5-1 FONT chart

<table>
<tr><th rowspan="2">Parameter (n)</th><th rowspan="2">Country</th><th colspan="12">Code position</th></tr>
<tr><th>2/3</th><th>2/4</th><th>4/0</th><th>5/B</th><th>5/C</th><th>5/D</th><th>5/E</th><th>5/F</th><th>7/B</th><th>7/C</th><th>7/D</th><th>7/E</th></tr>
<tr><td>0</td><td>STANDARD</td><td>#</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>↑</td><td>•–</td><td>{</td><td>¦</td><td>}</td><td>~</td></tr>
<tr><td>1</td><td>ISO</td><td>#</td><td>¤</td><td>@</td><td>[</td><td>\</td><td>]</td><td>\</td><td>_</td><td>{</td><td>|</td><td>}</td><td>–</td></tr>
<tr><td>2</td><td>Japan</td><td>#</td><td>$</td><td>@</td><td>[</td><td>¥</td><td>]</td><td>`</td><td></td><td>{</td><td>|</td><td>}</td><td>–</td></tr>
<tr><td>3</td><td>U. S. A.</td><td>#</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>'</td><td>_</td><td>{</td><td>¦</td><td>}</td><td>~</td></tr>
<tr><td>4</td><td>Britain</td><td>£</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>↑</td><td>_</td><td>{</td><td>|</td><td>}</td><td>–</td></tr>
<tr><td>5</td><td>Germany</td><td>£</td><td>$</td><td>§</td><td>Ä</td><td>Ö</td><td>Ü</td><td>`</td><td>_</td><td>ä</td><td>ö</td><td>ü</td><td>ß</td></tr>
<tr><td>6</td><td>France</td><td>£</td><td>$</td><td>à</td><td>○</td><td>Ç</td><td>§</td><td>\</td><td>_</td><td>·</td><td>ıı</td><td>ı</td><td></td></tr>
<tr><td>7</td><td>Sweden</td><td>£</td><td>$</td><td>@</td><td>Ä</td><td>Ö</td><td>Å</td><td>`</td><td>_</td><td>ä</td><td>ö</td><td>å</td><td>–</td></tr>
<tr><td>8</td><td>Denmark</td><td>£</td><td>$</td><td>@</td><td>Æ</td><td>Ø</td><td>Å</td><td>`</td><td>_</td><td>æ</td><td>ø</td><td>å</td><td>–</td></tr>
<tr><td>9</td><td>Spain</td><td>£</td><td>$</td><td>@</td><td>¡</td><td>Ñ</td><td>¿</td><td>\</td><td>_</td><td>|</td><td>ñ</td><td>}</td><td>–</td></tr>
</table>

Parameter n has the following meanings:

A. Selection of katakana characters (select a value of n from these two ranges):

(1) n = 0 - 9

Alphanumerics and symbols are in accordance with the FONT chart. Both katakana and Greek characters are included.

(2) n = 10 - 19

The same alphanumerics and symbols as those of n = 0 - 9. Katakana characters are not included, but the variety of Greek characters is increased.

B. Selection of patterns for 0 (zero) and O (oh) (select the value of n from these five ranges):

(zero) (oh)

① FONT$ 0～19

② FONT$ 20～39

③ FONT$ 40～59

④ FONT$ 60～79

⑤ FONT$ 80～99

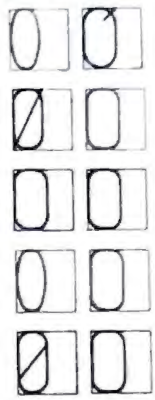


Fig. 7-5-10

In (2) - (5), characters other than 0 (zero) and O (oh) are the same as those for n = 0 - 19.

The resolution of the curved parts of the characters can be specified by the parameter m.

m is expressed as 2^k (k = 0 - 5).

In other words, m must be one of 1, 2, 4, 8, 16 or 32. The smaller the value of m, the smoother the curved parts of the characters; but the plotting speed will be slower because the curves are divided into larger numbers of segments. Select a suitable resolution to suit your purpose.

The initial setting is m = 4.

Parameter m can be omitted. If it is omitted, the value set previously remains effective.

m = 1 m = 2 m = 4 m = 8 m = 16 m = 32

Fig. 7-5-11

LP	LABEL POSITION command:	Setting of start point of character string

Command symbol LP (uppercase letters)

Function

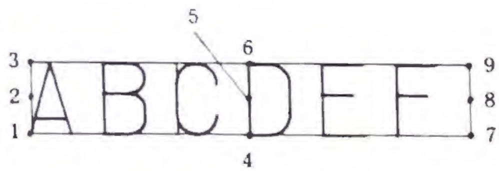
Moves the pen to the position specified as the start point of character string writing.

Input format LP n (terminator)

Statement example LPRINT "LP3";CHR$(3)

(This moves the point at which character writing starts one character equivalent downward.)

Parameter definition



The numbers in Fig. 7-5-12 are values of parameter n.

Fig. 7-5-12

This command moves the start point of character writing so that one of the points indicated by the values above becomes the current pen position.

Parameter range $1 \leq n \leq 9$ Initial setting is n = 1

Related commands P, K,

Description

This command moves the point at which the writing of a character string starts to the position specified by parameter n.

When writing a string of characters, the current pen position usually becomes the lower left point of the

first character. But by using this command, you can make the desired point of the character string, specified by n, becomes the current pen position, by automatically moving the position of the character string itself. (Writing still starts from the first character in the string.)

Parameter n is valid within the range of 1 to 9; the initial setting is n = 1.

If a value outside this range is specified, it is ignored and n = 1 is assumed.

n = 1 - 3 specify the beginning of the character string, n = 4 - 6 its center, and n = 7 - 9 its end, as the current pen position.

n = 2, 5, or 8 moves the position downward by half a character equivalent, and n = 3, 6, or 9 moves it by one character equivalent, from the n = 3, 6, or 9 position, respectively.

The position of the pen after the completion of the drawing is 7 when n = 1, 4, or 7, 8 when n = 2, 5, or 8, or 9 when n = 3, 6, or 9.

All characters written by "P", "K" commands are affected by this command. (However, control characters - CR, LF, BS, etc. - are not included in character strings.)

The characters drawn by "(" and "(P" commands are not affected.

The start point of drawing set by this command remains valid until it is respecified, the "A" command is issued, or the plotter is initialized.

A	ALPHA RESET command:	Initialization of character-writing commands

Command symbol	A (uppercase letter)
Function	Initializes the parameters of commands relating to character and symbol writing.
Input format	A
Statement example	LPRINT "A"
Description	This command returns the parameters of the following character and symbol setting commands to the values set at the initialization of the plotter:

FONT	"$"	n = 60, m = 4
ALPHA SCALE	"S"	n = 30, m = 30
ALPHA SPACE	"Q"	ℓ = 30, m = 0
ALPHA ROTATE	"R"	θ = 0
ALPHA ITALIC	"I"	p = 0
LABEL POSITION	"LP"	n = 1

X	AXIS command: Coordinate axis drawing

Command symbol X

Function Draws a coordinate axis and scale lines parallel to either the X- or Y-axis.

Input format X p , q , r [, t_1 [, t_2]] (terminator)

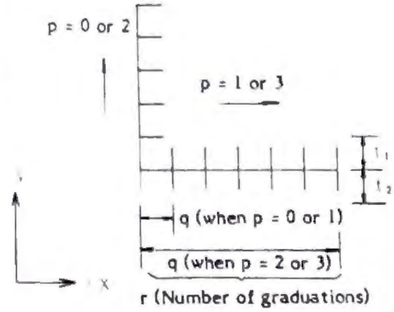
Statement example LPRINT "X1,100,10,0,10";CHR$(3)

Parameter definitions

P	Axial direction	q	r
0	Y	Unit length	Number of repeats
1	X	Unit length	Number of repeats
2	Y	Total length	Number of divisions
3	X	Total length	Number of divisions

t_1: Length of scale marks in positive direction

t_2: Length of scale marks in negative direction



* When t_1 and t_2 are omitted, or both are 0: $t_1 = t_2 = 10$

Fig. 7-6-1

Parameter ranges

$0 \leqq p \leqq 3$

$-16383 \leqq q \leqq 16383$

$1 \leqq r \leqq 16383$

$0 \leqq t_1, t_2 \leqq 16383$

Description

This command starts drawing from the current pen position. Specify the Y coordinate axis by p = 0 or 2, and the X coordinate axis by p = 1 or 3.

The meanings of parameters q, r depend on the value of p.

When p is 0 or 1, q specifies the length of a single graduation and r the number of its repeats.

When p is 2 or 3, q specifies the total length of the coordinate axis and r the number of divisions. Decimal points and decimal fractions in both q and r are truncated.

When q is a positive number, the X-axis is drawn to the right and the Y-axis upward, from the current pen position. When q is a negative number, the X-axis is drawn to the left and the Y-axis downward, from the current pen position.

By specifying t_1 and t_2, it is possible to change the lengths of scale marks or lines. ($t_1 + t_2 = 20$ is assumed when these parameters are omitted.) Grids and tables can be made by using this function.

% HATCHING command (1): Drawing of rectangles and hatching

Command symbol	%
Function	Draws a rectangle parallel to the X-and Y-axes, and hatches inside it.
Input format	%n , x , y , d , θ (terminator)
Statement example	LPRINT "%3 , 500, 200, 20, 450" ; CHR $ (3) This draws a rectangle of 500 x 200 units, and hatches it with a hatching pattern of a line spacing of 20 at an angle of 45°.

Parameter definitions

n = 1:	Rectangle only
n = 2:	Hatching only
n = 3:	Rectangle with internal hatching
x:	Length in X-axis direction (integral multiple of GDU)
y:	Length in Y-axis direction (integral multiple of GDU)
d:	Line spacing of hatching (integral multiple of GDU)
θ:	Angle of hatching from X-axis (integral multiple of 0.1°, measured positively in the counterclockwise direction and negatively in the clockwise direction.)

Parameter ranges $1 \leqq n \leqq 3$

$$-16383 \leqq x, y \leqq 16383$$

$$0 < d \leqq 4000$$

$$-3600 \leqq \theta \leqq 3600$$

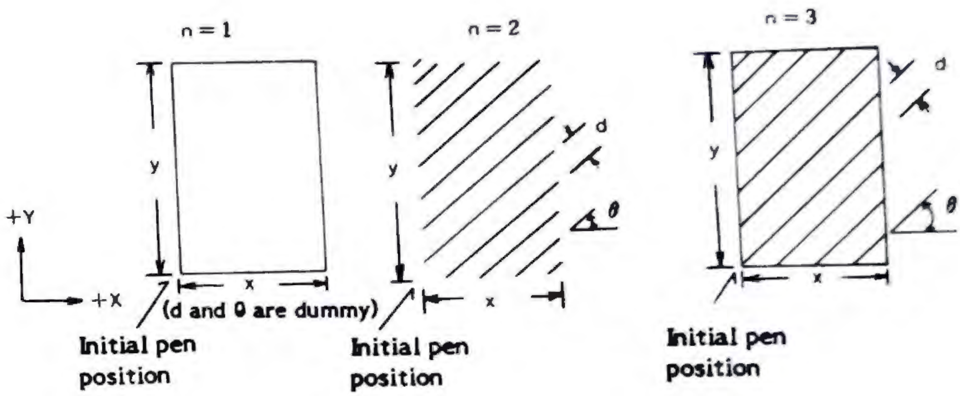


Fig. 7-6-2

Related commands L , B , ↑P

Description

This command draws a rectangle parallel to the X- and Y-axes, and hatches inside it.

The drawing starts from the current pen position which becomes the lower left corner of the rectangle.

Parameters x and y specify the lengths of the sides of the rectangle in the horizontal and vertical directions, respectively. For hatching, they specify the lengths of the hatched area along the X- and Y-axes. Parameter d specifies the line spacing of the hatching; do not specify it as 0. Note that if this parameter is too large, hatching cannot be drawn within the rectangle.

(To fill in a rectangle completely and neatly when using a fiber-tip pen, specify parameter d as 5 or less.)

Parameter θ specifies the slope of hatching lines as an angle from the X-axis. Specify the angle as an integral multiple of 0.1°, measured positively in the counterclockwise direction.

(When the "↑P" command is executed, this parameter gives the angle from the angle reference set by parameter θ_0, expressed as an integral multiple of the angle unit set by parameter f).

Parameters d, θ are ignored when n = 1, but they cannot be omitted because they are necessary as dummy parameters.

Any line type specification by the "L" and "B" commands affects the frame line of the rectangle only, not the hatching lines.

Only the angle parameter is affected by the "↑P" command.

Example

```
LPRINT"%3,500,200,20,450";CHR$(3)
```

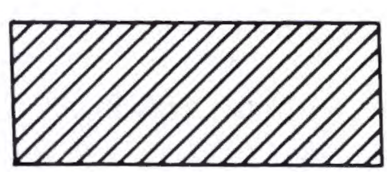


Fig. 7-6-3

%	HATCHING command (2): Hatching of circle or fan shape

Command symbol %

Function Draws a fan shape and hatches inside it.

Input format %n , r_1, r_2, θ_1, θ_2, d, θ_3 (terminator)

Statement example LPRINT "%13, 200, 500, 0, 450, 20, 450 " ; CHR$(3)

Parameter definitions

n = 11:	Fan shape only
n = 12:	Hatching of fan shape only
n = 13:	Fan with internal hatching
r_1:	Radius of outer circle of fan (integral multiple of GDU)
r_2:	Radius of inner circle of fan (integral multiple of GDU)
θ_1, θ_2:	Range of drawing (betwen θ_1 and θ_2, expressed as integral multiples of 0.1°)
d:	Line spacing of hatching (integral multiple of GDU)
θ_3:	Angle of hatching from X-axis (integral multiple of 0.1°, measured positively in the counterclockwise direction and negatively in the clockwise direction)

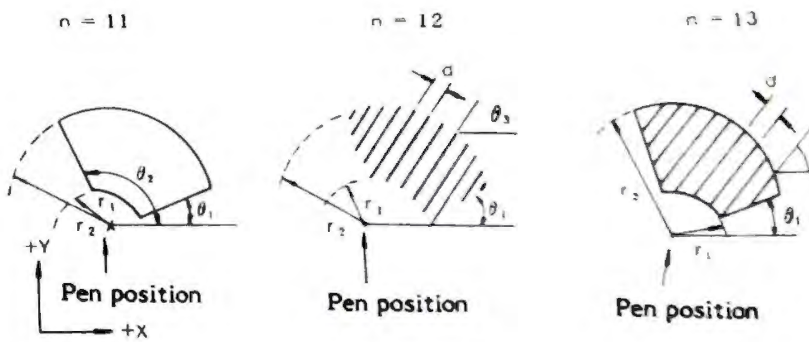


Fig. 7-6-4

Parameter ranges $0 \leqq r_2 \leqq 4000$, $0 < r_1 \leqq 4000$, $r_2 < r_1$

$-3600 \leqq \theta_1, \theta_2, \theta_3 \leqq 3600$ * $| \theta_1 - \theta_2 | \leqq 3600$

$0 < d \leqq 4000$

Related commands L , B , ↑P

Description

This command draws a fan shape centered on the current pen position, and hatches inside it.

Specify the size of the outer and inner circles by parameters r_1 and r_2, respectively. Straight line segments drawn from r_1 to r_2 to close the fan shape are also drawn when full circles are specified by θ_1 and θ_2. (Drawn from the center of the circle when $r_2 = 0$.)

Parameter d specifies the line spacing of hatching; do not specify it as 0. Note that if this parameter is too large, hatching cannot be drawn.

(To fill in the fan shape completely, specify parameter d as 5 or less.)

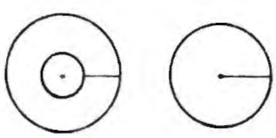


Fig. 7-6-5

Parameters θ_1 and θ_2 express the range of the fan shape and θ_3 gives the slope of the hatching lines, in integral multiples of 0.1° with respect to the +X-axis direction.

* When the "↑P" command is executed, these parameters give the angle from the angle

reference set by parameter θ_0, expressed as integral multiples of the angle unit specified by parameter f.

Parameters d and θ_3 are ignored when n = 11, but they cannot be omitted because they are necessary as dummy parameters.

Any line type specification by the "L" and "B" commands affects the frame lines only, not the hatching lines.

Only the angle parameters are affected by the "↑P" command.

%	HATCHING command (3):	Drawing and hatching of any string of points

Command symbol %

Function: Draws any desired string of points and hatches inside it.

Input format: %n, d, θ, x_1, y_1, x_2, y_2, ... x_n, y_n (terminator)

Statement example: LPRINT "%23, 20, 450,500,500,1500,500,1000,1500" ;CHR$(3)

Parameter definitions
- n = 21: Point string only
- n = 22: Hatching within point string only
- n = 23: Point string with internal hatching
- d: Line spacing of hatching (integral multiple of GDU)
- θ: Angle of hatching from X-axis (integral multiple of 0.1°, measured positively in the counterclockwise direction and negatively in the clockwise direction)
- x_n, y_n: Coordinates of points in string (integral multiples of GDU)

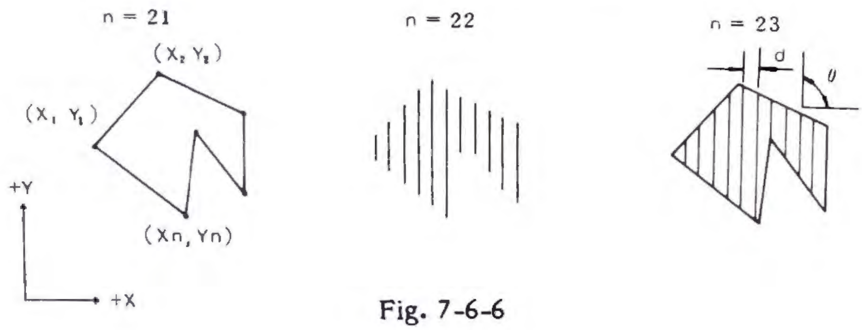


Fig. 7-6-6

Parameter ranges

$0 < d \leqq 4000$

$-3600 \leqq \theta \leqq 3600$

* When the "↑P" command is executed:

$-32767 \leqq \theta \leqq 32767$

$-16383 \leqq x_n, \ y_n \leqq 16383$

Related commands

L, B, >, ↑P

Description

This command draws a string of points and hatches the area enclosed by it.

Specify the string of points as the absolute coordinates of the points which enclose the area to be hatched. Do not specify the start point again as the end point; a line connecting the start and end points will be drawn automatically.

Do not give the same data point twice in succession.

Parameter d specifies the line spacing of the hatching; it cannot be 0.

Note that when this parameter is too large, hatching cannot be drawn. (To fill in the specified area, specify parameter d as 5 or less.)

Parameter θ specifies the angle of hatching from the X-axis as an integral multiple of 0.1°, measured positively in the counterclockwise direction.

When the "↑P" command is executed, this parameter gives the angle from the angle reference specified by parameter θ_0, expressed as an integral multiple of the angle unit specified by f.

Parameters d and θ are ignored when n = 21, but cannot be omitted because they are necessary as dummy parameters.

- o Note the following restrictions on the number of data points:

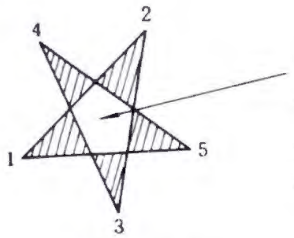
  Hatching and clipping data is processed after being stored in the memory, so the number of data point is limited to:

  Number of clipping data points: maximum (200 points - number of clipping pattern points)

  Number of hatching data points: 200 - (number of clipping data points + number of clipping pattern points)

  This means that up to 200 points can be specified if there is no clipping.

- o When line segments cross each other, as in the figure below, an area without hatching is produced.



The numbers give the sequence in which the points were specified.

Fig. 7-6-7

- o Keep the maximum number of intersections between one hatching line and a point string pattern at 30. If there are more than 30 intersections, hatching is not done from intersection 31 onward.

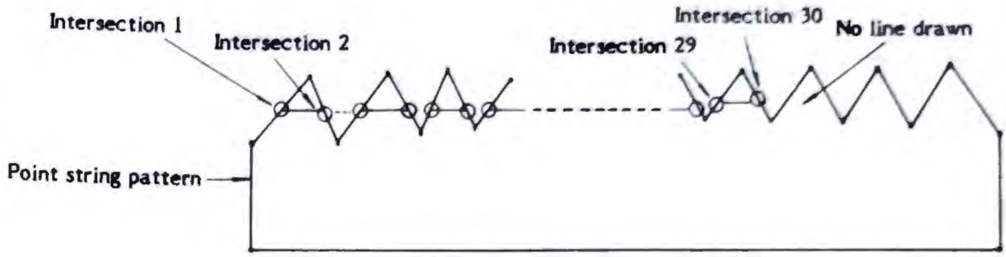


Fig. 7-6-8

Any line type specification by the "L" and "B" commands affects the frame lines only, not the hatching lines.

SP	SELECT POINT MARK command: Specification of marks

Command symbol	SP (uppercase letters)
Function	Draws the specified character or mark at the end point of a straight line segment or a movement.
Input format	SPc (terminator)
Statement example	LPRINT "SPX"; CHR$(3) This draws an "X" at the end of each line segment or movement
Parameter range	c : $10_{(H)} \sim 7E_{(H)}$ $90_{(H)} \sim FE_{(H)}$
Related commands	M, D, E, O, MP, DP, EP, OP, Y, ←
Description	This command is useful for drawing graphs, etc., because it draws a specified character or mark at the end of each straight line segment or, in the case of a curve, at each specified coordinate point.

The characters and marks specified by this command are influenced by the character setting commands "S", "Q", "R", "I" and "A".

The marks provided by the MARK command "N" can also be specified by this command. This is explained below. (The same procedure can be used when specifying characters, etc., which are not available on the keyboard.)

Example

LPRINT "SP";CHR$(19);CHR$(3)

The codes for marks are:

CHR$(17 ~ 32)

Refer to the code charts for details.

Fig. 7-6-9

* The character or mark drawn by this command is centered on the point to which the pen moves, although the center may be offset slightly, depending on the character or mark drawn.

& FACTOR command: Specification of plotting magnification

Command symbol	&
Function	Enlarges or reduces the plotting.
Input format	& p , q , r ,
Statement example	LPRINT "& 1 , 2 , 2 , "
Parameter definitions	p/r: Magnification along X-axis q/r: Magnification along Y-axis
Parameter ranges	$0 < p , p , r \leqq 32767$ $\frac{1}{4096} < \frac{p}{r} , \frac{q}{r} < 8$ (Coordinate values before multiplication by FACTOR) $* \left(\frac{p}{r} \text{ or } \frac{q}{r}\right) \leqq 16383$
Related commands	The FACTOR command affects all plotting commands except UR, LL, OFFSET, and ROTATE.
Description	This command specifies the magnification (enlargement and reduction) of the plotting. All coordinates, lengths, character sizes, etc., are multiplied by p/r or q/r, but the values of the parameters of the OFFSET, UR, and LL commands are not affected. The initial setting of the parameters is p = q = r = 1.

Example LPRINT"&1,2,2,"

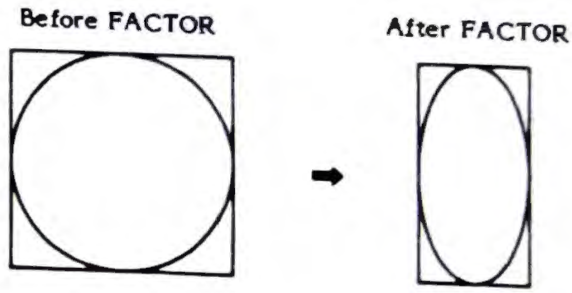


Fig. 7-7-1

/ ROTATE command: Rotation of coordinate system

Command symbol /

Function Rotates all coordinates.

Input format ⁄ x , y , θ ,

Statement example LPRINT "⁄500,500,450,"

This rotates the coordinate system through 45° (450) about (500, 500).

Parameter definitions (x, y): Center of rotation

Distances from coordinate origin, integral multiples of GDU

Distances from OFFSET point when OFFSET is executed.

θ: Angle of rotation

Integral multiple of 0.1°, measured positively in the counterclockwise direction from the +X direction as 0°.

Parameter ranges $-16383 \leqq x, y \leqq 16383$ Initial setting is (0, 0)

$-32767 \leqq \theta \leqq 32767$ Initial setting is 0

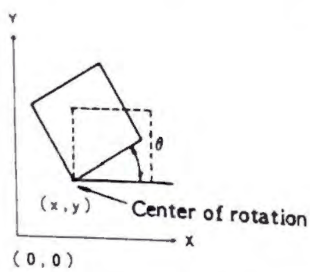


Fig. 7-7-2

Related commands ↑ , ↑P

Description	This command rotates the coordinate system through the angle specified by θ, centered on the coordinates (x, y) from the coordinate origin (or the OFFSET point when OFFSET is executed).

Express parameters x and y as integral multiples of the GDU; they are valid from -16383 to 16383.

Express θ as an integral multiple of 0.1°; it is valid from -32767 to 32767. All decimal points and decimal fractions are truncated.

Note that if (x, y) is specified outside the valid plotting area, plotting may not be done.

Once this command is issued, all subsequent plotting is affected, and the parameters of the command remain valid until they are reset or the plotter is initialized.

The center of rotation is not affected by the FACTOR command.

↑	OFFSET command: Movement of coordinate origin

Command symbol	↑ * "∧" in JIS code.
Function	Moves the coordinate origin of the plotting.
Input format	↑ x , y ,
Statement example	LPRINT "↑500,500," This specifies point (500, 500) as the coordinate origin.
Parameter ranges	$-16383 \leqq x, y \leqq 16383$ x, y (integral multiples of GDU) and $-16383 \leqq x + X_0 \leqq 16383$ $-16383 \leqq y + Y_0 \leqq 16383$ X_0: Maximum or minimum value of X coordinate before OFFSET Y_0: Maximum or minimum value of Y coordinate before OFFSET
Related command	↑P
Description	This command moves the coordinate origin (0, 0) to the coordinate point specified by (x, y), relative to the HOME position in the absolute coordinate system. (OFFSET point setting) The plotting area moves at the same time, but the HOME position doesn't move. Specify parameters x and y as integral multiples of the GDU, within the range of -16383 to 16383.

This command affects all plotting commands received after it, and the values of its parameters remain effective until they are reset or the plotter is initialized.

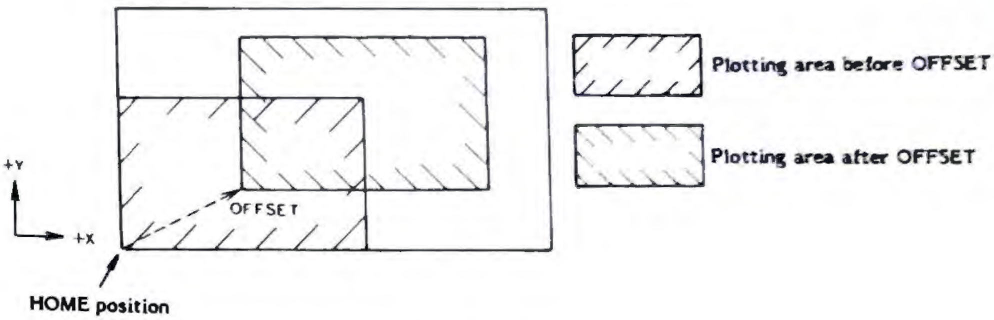


Fig. 7-7-3

\	WRITE LOWER LEFT commands:	Specification of plotting area
Z	WRITE UPPER RIGHT commands:	

Command symbols WRITE LOWER LEFT \ * "¥" in JIS code
WRITE UPPER RIGHT Z

Function Specify the plotting area.

Input formats WRITE LOWER LEFT \x, y,
WRITE UPPER RIGHT Zx, y,

Statement example LPRINT "\100,100,Z2000,2000,"

This specifies a range defined by the opposite corners (0, 0) and (2000, 2000) as the valid plotting area.

Parameter range $-16383 \leqq x, y \leqq 16383$

Description Use these commands to specify the coordinates of the corners (LOWER LEFT, UPPER RIGHT) of the plotting area from the controller.

Express parameters x and y as coordinates which are integral multiples of 0.1 mm from the OFFSET point (see the description of the OFFSET command " ↑ ").

The initial setting of LOWER LEFT is (0, 0), and that of UPPER RIGHT gives the maximum valid plotting area: (4000, 2850).

Once the valid plotting area is specified by these commands, plotting outside that area will not be done. This function can be used to omit part of a drawing deliberately. For the plotting area, see Section 7-11-4 Plotting area and off scale.

When the coordinate origin is moved by the OFFSET command, the plotting area moves at the same time.

Therefore, when the coordinate origin itself is moved, the WRITE LOWER LEFT command makes it possible to specify negative coordinate values, so that negative coordinates can be used as well in the plotting.

>	CLIPPING command:	Clipping of plot

Command symbol >

Function: Sets an area in which plotting is inhibited, within the valid plotting area. (Clipping pattern setting)

Input formats: >x_1, y_1, x_2, y_2, …… x_n, y_n (terminator)
> (terminator)

Statement example: LPRINT" >500,500,1000,500,1000,1000,500,1000,
500,500";CHR$(3)

This inhibits any subsequent plotting within a square area with sides of 50 mm (500), the lower left corner being the point (500, 500).

Parameter definition: x_n, y_n: String of points defining the clipping pattern. (Absolute coordinate system) (Integral multiples of GDU)

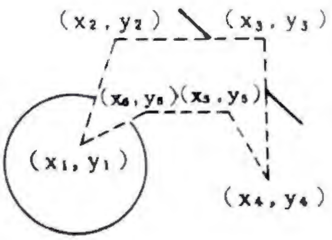
Parameter range: $-16383 \leq x, y \leq 16383$
Number of points given by $(x_n, y_n) \leq 200$

Related commands: ↑, %

Description: This command clips part of the plotting (blanks it out).

When this command sets an area enclosed by the string of points (x_n, y_n) in the absolute coordinate system, all subsequent plotting within that area is prevented.

Example



* Plotting cannot be guaranteed along the lines of the clipping pattern, so if you want to draw a line around the clipping pattern, use the clipping pattern data to draw the line first, then execute the CLIPPING command.

Fig. 7-7-4

More than one clipping pattern can be specified, but note that the following restrictions are placed on the maximum number of points defining them.

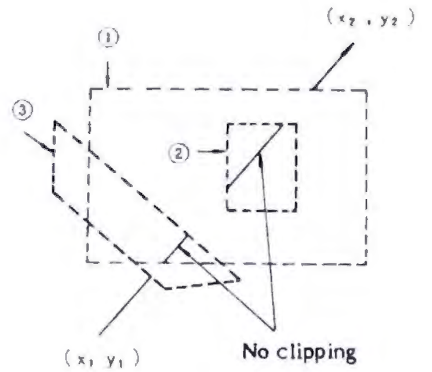
Clipping and hatching data is processed after being stored in the memory, so the number of data points is limited to:

(1) Number of clipping data points: Maximum (200 data points - number of clipping pattern points)

(2) Number of hatching data points: 200 - (number of clipping data points + number of clipping pattern points)

If these limits are exceeded, data received subsequently is considered to be a parameter overflow error, and is ignored as far as a terminator.

If clipping patterns overlap, an area is generated in which there is no clipping.



If the three clipping patterns shown in Fig. 7-7-5 are specified, and a straight line is drawn from point (x_1, y_1) to point (x_2, y_2), parts of the line will be drawn within the overlapped clipping areas.

Fig. 7-7-5

Keep the maximum number of intersections between a plotting line and a clipping pattern at 30. If there are more than 30 intersections, clipping will not be done from intersection 31 onward.

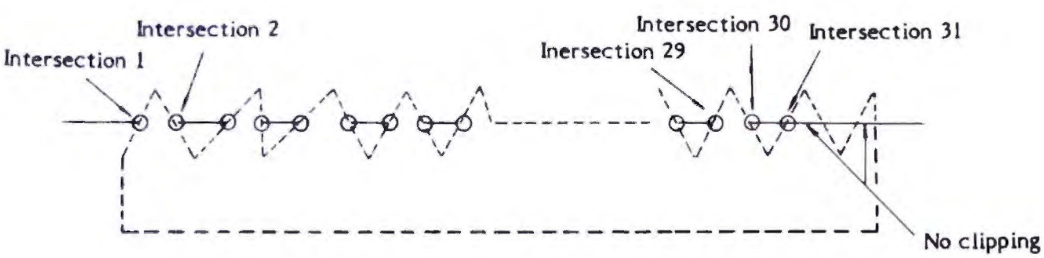


Fig. 7-7-6

To clear the clipping specification, either initialize the plotter or execute a CLIPPING command without any parameters.

This clears all the clipping data.

* It is not possible to clear only a selected clipping pattern.

Example `LPRINT ">";CHR$(3)`

•	CLEAR command: Clearing of settings

Command symbol	:
Function	Initializes the plotter and returns all settings to their initial values. (Direct command)
Input format	:
Statement example	LPRINT ":" ;
Description	As soon as the plotter receives this command, it is initialized to the status it had when power was turned on, so that all settings are cleared and returned to their initial values. * Leave at least 2 seconds between this and the next command. * Be careful using this command during or at the end of a program; it will clear all data in the plotter's buffer.

;	INTERFACE CLEAR command: Clearing of interface settings

Command symbol ; (semi-colon)

Function Clears I/O errors and data within the buffer memory, and returns the terminator to its initial setting.

Input format ;

Statement example LPRINT " ; " ;

Description As soon as the plotter receives this command, I/O errors and data within the buffer memory are cleared, the terminator setting is returned to (ETX), and all interface conditions are initialized. (Direct command)

However, if the following command parameters are already set, they are all preserved:

LINE TYPE	"L"	WRITE LOWER LEFT	"\"
LINE SCALE	"B"	WRITE UPPER RIGHT	"Z"
FONT	"$"	OFFSET	"↑"
ALPHA SCALE	"S"	FACTOR	"&"
ALPHA SPACE	"Q"	CLIPPING	">"
ALPHA ITALIC	"I"	ROTATE	"/"
ALPHA ROTATE	"R"	LABEL POSITION	"LP"

* Leave at least 10 ms between this command and the next.

* Be careful about using this command during or at the end of a program; it will clear all data in the plotter's buffer.

H	HOME command: Return to HOME position

Command symbol	H (uppercase letter)
Function	Moves the pen to the HOME position (mechanical origin).
Input format	H
Statement example	LPRINT "H"
Description	This command returns the raised pen to the HOME position (mechanical origin). The HOME position is not affected by the setting of the plotting area.

J NEW PEN command: Pen exchange

Command symbol: J

Function: Specifies an exchange of pens.

Input format: J n ,

Statement example: LPRINT "J 2 ,"

Parameter range: $0 \leqq n \leqq 8$

Description:

If this command is executed when a pen has been exchanged, the pen specified by parameter n is automatically selected.

Pen 1 is selected when the plotter is initialized.

If this command is not issued, the plotter will always use Pen 1 for drawing. When n = 0, the pen currently being used (the one in the pen carriage) is returned to the pen station.

When a plotting command is completed, or is suspended for 8 seconds or more, the pen carriage automatically returns its pen to the pen station (this is called the auto pen-stock operation) to prevent the ink drying up, and then waits for the next command at the position it was at before it returned the pen.

When the command is restarted, the carriage picks up the pen it had previously returned to the station, unless a pen exchange is instructed by the "J"

command, and starts drawing from the position it was at before it returned the pen.

* When the plotter is initialized, the pen carriage stands by at the HOME position, then takes a pen from the station after it receives a plotting command.

* If an n = 0 "J" command is issued when the pen has been returned to the station by the auto pen-stock operation, the number of the pen is cleared from the memory (but the pen carriage does not move).
If a plotting command is executed in this state, the plotter (carriage) operates without holding a pen, unless a pen exchange command is received.

J	NEW PEN command: Pen exchange

Command symbol	J
Function	Specifies an exchange of pens.
Input format	J n ,
Statement example	LPRINT "J 2 ,"
Parameter range	$0 \leq n \leq 8$

Description

If this command is executed when a pen has been exchanged, the pen specified by parameter n is automatically selected.

Pen 1 is selected when the plotter is initialized.

If this command is not issued, the plotter will always use Pen 1 for drawing. When n = 0, the pen currently being used (the one in the pen carriage) is returned to the pen station.

When a plotting command is completed, or is suspended for 8 seconds or more, the pen carriage automatically returns its pen to the pen station (this is called the auto pen-stock operation) to prevent the ink drying up, and then waits for the next command at the position it was at before it returned the pen.

When the command is restarted, the carriage picks up the pen it had previously returned to the station, unless a pen exchange is instructed by the "J"

command, and starts drawing from the position it was at before it returned the pen.

* When the plotter is initialized, the pen carriage stands by at the HOME position, then takes a pen from the station after it receives a plotting command.

* If an n = 0 "J" command is issued when the pen has been returned to the station by the auto pen-stock operation, the number of the pen is cleared from the memory (but the pen carriage does not move).
  If a plotting command is executed in this state, the plotter (carriage) operates without holding a pen, unless a pen exchange command is received.

!	SPEED command: Pen speed

Command symbol !

Function Specifies the speed of the pen when it is down.

Input format /ℓ [, n] (terminator)

Statement example LPRINT "/5";CHR$(3)

Parameter ranges $0 \leq \ell \leq 10, 100 \leq \ell \leq 125$

$1 \leq n \leq 8$

Description This command specifies the plotting speed in 10 stages by parameter ℓ. The pen speed is given by: $V \doteqdot \ell * 250/10$. (Where ℓ = 1 to 10)

The pen speed when it is raised is always 400 mm/s, regardless of the specification of this command.

Parameter n specifies the number of the pen whose speed is to be changed. When this is omitted, the command applies to all the pens.

The relationship between parameter ℓ and pen speed is given below.

0	1	2	3	4	5
250mm/s	25mm/s	50mm/s	75mm/s	100mm/s	125mm/s

6	7	8	9	10
150mm/s	175mm/s	200mm/s	225mm/s	250mm/s

It is also possible to specify the plotting speed in steps of 10 mm/s, by setting the value of parameter ℓ within the range of 100 to 125.

In this case, the plotting speed is (ℓ - 100). When ℓ = 100, however, the speed is 250 mm/s; the same as that when ℓ is 0.

T PROMPT LIGHT command:

Command symbol	T (uppercase letter)
Function	Turns on and off the ALARM/PROMPT lamp on the control panel.
Input format	Tn ,
Statement example	LPRINT "T1, "
Parameter definitions	n = 0: Turns off the ALARM/PROMPT lamp n = 1: Turns on the ALARM/PROMPT lamp
Description	This command turns on and off the PROMPT lamp which also acts as the ALARM lamp in the MP2000. This is used by the computer to attract the operator's attention, or to tell him that the plotter is ready to receive input. Parameter n is valid only when it is 1 or 0.

"	ERROR MASK command: Masking of error status

Command symbol "

Function Masks the error status.

Input format "m, n, p,

Statement example PRINT # 1 , CHR$(34) ; "17,0,0,"

Parameter definitions m: Error mask m = 0 to 63 (initial setting is 1)

Each error can be masked so that its error indication disappears, by making the corresponding bit 0. If the bit of an error is 1, an error indication is given whenever that error occurs. This error masking affects the display on the control panel and the error statuses given by READ STATUS WORD 1 and READ STATUS WORD 3.

MSB 7	6	5	4	3	2	1	0 LSB
		E_6	E_5	E_4	E_3	E_2	E_1

E_1: Command error E_4: Parameter error
E_2: Terminator error E_5: I/O error
E_3: Delimiter error E_6: Off scale

The values of all the bit settings are converted from binary into a decimal number and output.

n: Service request mask n = 0 to 15 (initial setting is 0)

This is effective only with the GP-IB interface. When a request occurs and the corresponding bit is 1, that service request is given.

The bits of the service request mask are shown below.

When using the RS-232-C or Centronics interface, zeroes must be specified as dummies.

MSB 7	6	5	4	3	2	1	0
0	0	0	0	S_4	S_3	S_2	S_1

S_1: Output request (when asking for data output from plotter)

S_2: Error (when an error has occured)

S_3: Buffer empty (when there is at least 1536 bytes of unused buffer space)

S_4: Buffer full (when there is 128 bytes or less of unused buffer space)

When one of the above statuses occurs, the corresponding service request is output.

p: Parallel-poll mask p = 0 to 15 (initial setting is 0.)

This is effective only with the GP-IB interface. When a parallel poll indication is received by setting that bit to 1, a response is sent to that masked bit. (The response bit depends on PPC, PPE.)

The parallel poll bits are the same as those of the service request mask.

When using the RS-232-C or Centronics interface, zeroes must be specified as dummies.

Example " 255, 1, 1,

This cancels the error mask and indicates all the errors.
Service request and parallel polling respond during data output.

Description

This command masks the error status of the plotter so that the generation of errors can be ignored, but an error display can be provided from the error contents. This command can also provide a mask of the causes of services requests and parallel polling in the GP-IB interface.

=	TERM command: Terminator setting

Command symbol =

Function: Specifies the data terminator(s).

Input format: $= t_1 \ t_2$

Statement example: PRINT # 1 , "=" ; CHR$ (13) ; CHR$ (10) ;

Parameter definitions

1) For data reception:
Either of the characters t_1 or t_2, or the sequence of two characters t_1 t_2, is handled as terminator.

2) For data transmission:
The sequence t_1 t_2 is added to the end of output data. When t_1 and t_2 are the same, only one character is added.

Note that t_1 and t_2 cannot be any of the characters used in command bytes, the numerals from 0 to 9, "-" (minus sign), or $(60)_{16}$ to $(7F)_{16}$.

Use codes from $(00)_{16}$ to $(1F)_{16}$.

Description

This command changes the terminator(s).

It may be difficult to read data output from the plotter if CR LF is not inserted at the end of the data. If this happens, it is necessary to use this command to change the terminator to CR LF.

G	GIN command: Digitization

Command symbol	G	
Function	Outputs the coordinates of the pen (absolute coordinates) and its status (pen number, pen up or down) to the computer.	
Input format	G	
Statement example	PRINT # 1 , "G"	
Output format	Data output from plotter x, y, p (terminator)	
Parameter definitions	x:	X coordinate, 6 digits
	y:	Y coordinate, 6 digits
	p:	Pen status, 6 digits
		When p = 10: Pen 1 is up
		When p = 11: Pen 1 is down
		When p = 20: Pen 2 is up
		When p = 21 Pen 2 is down
		. . .

Description

This command transmits the X and Y coordinates of the current pen position and the pen status to the computer.

The data output from the plotter in response to this command gives each of the X and Y coordinates and the status of the pen as a 6-digit decimal number, including a 1-digit sign ("-" or, for a positive

number, a space). Any zeroes to the left of significant digits are output as spaces.

```
□□□□□□ , □□□□□□ , □□□□□□ Terminator
  x    Delimiter  y   Delimiter  P
       (comma)
```

Usage example

```
      ⁄
100 PRINT#1,"=";CHR$(13);CHR$(10): Terminator change
      ⁄
    PRINT#1,"G"
    INPUT#1,X,Y,P
    PRINT X,Y,P          (X, Y):    Current pen coordinates
      ⁄                  P:         Pen status
```

C CALL GIN command: Digitization

Command symbol	C
Function	Puts the plotter in digitization mode, and outputs the coordinates of the pen (absolute coordinates) and its status (pen number, pen up or down) to the computer.
Input format	C
Statement example	PRINT # 1 , "C"
Output format	Data output from the plotter x, y, p (terminator)

Parameter definitions

x: X coordinate, 6 digits

y: Y coordinate, 6 digits

p: Pen status, 6 digits

When p = 10:	Pen 1 is up
When p = 11:	Pen 1 is down
When p = 20:	Pen 2 is up
When p = 21	Pen 2 is down
.	.
.	.
.	.

Description

This command puts the plotter in digitization mode, and transmits to the computer the coordinates and status of the pen when the pen has been moved by a keyboard operation to any desired point.

When this command is executed, the PROMPT lamp flashes.

If you now move the pen and press the ENTER key, the X and Y coordinates and status of the pen at that time will be output.

The data output from the plotter gives each of the X and Y coordinates and the status of the pen as a 6-digit decimal number, including a 1-digit sign ("-" or, for a positive number, a space). Any zeroes to the left of significant digits are output as spaces.

```
□□□□□□ , □□□□□□ , □□□□□□ (Terminator)
   x   Delimiter  y  Delimiter  p
```

Usage example

```
        ≀
100 PRINT#1,"=";CHR$(13);CHR$(10):   Terminator change
        ≀
    PRINT#1,"C"
    INPUT#1,X,Y,P
    PRINT X,Y,P          (X, Y):   Current pen coordinates
        ≀                P:        Pen status
```

C	CALL GIN command: Digitization

Command symbol C

Function

Puts the plotter in digitization mode, and outputs the coordinates of the pen (absolute coordinates) and its status (pen number, pen up or down) to the computer.

Input format C

Statement example PRINT #1, "C"

Output format

Data output from the plotter

x, y, p (terminator)

Parameter definitions

x: X coordinate, 6 digits

y: Y coordinate, 6 digits

p: Pen status, 6 digits

When p = 10:	Pen 1 is up
When p = 11:	Pen 1 is down
When p = 20:	Pen 2 is up
When p = 21	Pen 2 is down
.	.
.	.
.	.

Description

This command puts the plotter in digitization mode, and transmits to the computer the coordinates and status of the pen when the pen has been moved by a keyboard operation to any desired point.

When this command is executed, the PROMPT lamp flashes.

If you now move the pen and press the ENTER key, the X and Y coordinates and status of the pen at that time will be output.

The data output from the plotter gives each of the X and Y coordinates and the status of the pen as a 6-digit decimal number, including a 1-digit sign (– or, for a positive number, a space). Any zeroes to the left of significant digits are output as spaces.

[illegible]

X Delimiter Y Delimiter [illegible]

Usage example

```
100 PRINT#1, [illegible]
    PRINT#1, [illegible]
    INPUT#1, X, Y, [illegible]
    PRINT X, Y, [illegible]
```

?	READ OFFSET command: Read-out of coordinate origin

Command symbol ?

Function Outputs the coordinates of the origin (OFFSET point) to the computer.

Input format ?

Statement example PRINT # 1 , " ? "

Output format Data output from the plotter

x, y (terminator)

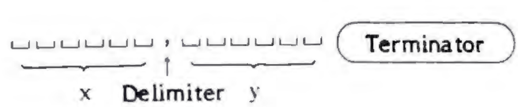
Parameter definitions x: X coordinate of origin, 6 digits

y: Y coordinate of origin, 6 digits

The values (x, y) are the coordinates relative to the HOME position, output as integral multiples of the GDU.

Description This command outputs the X and Y coordinates of the currently-set coordinate origin to the computer.

When this command is executed, the data output from the plotter gives each of the X and Y coordinates as a 6-digit decimal number, including a 1-digit sign ("-" or, for a positive value, a space). Any zeroes to the left of significant digits are output as spaces.



Usage example

```
100 PRINT#1,"=";CHR$(13);CHR$(10);
    /
    PRINT#1,"?"
    INPUT#1,X,Y
    PRINT X,Y
    /
```

(X, Y): Coordinates of the coordinate origin (OFFSET point)

[	READ LOWER LEFT command	Read-out of valid plotting area
U	READ UPPER RIGHT command	

Command symbols [(READ LOWER LEFT)
U (READ UPPER RIGHT)

Function Output to the computer the coordinates of the LOWER LEFT and UPPER RIGHT corners of the valid plotting area.

Input formats [(READ LOWER LEFT)
U (READ UPPER RIGHT)

Statement examples PRINT#1, "[" (READ LOWER LEFT)
PRINT#1, "U" (READ UPPER RIGHT)

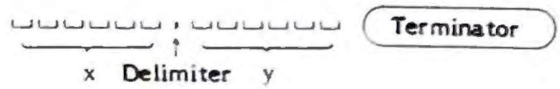
Output formats Data output from plotter
x, y (terminator)

Parameter definitions x: x coordinate of LOWER LEFT or UPPER RIGHT corner, 6 digits
y: y coordinate of LOWER LEFT or UPPER RIGHT corner, 6 digits
The coordinates (x, y) are given relative to the OFFSET point. They are affected by FACTOR, so are expressed in GDU.

Description These commands output the x and y coordinates of the LOWER LEFT (L. L.) or UPPER RIGHT (U. R.) corners of the valid plotting area which is currently set.

The data output from the plotter in response to these commands gives each of the x and y

coordinates as a 6-digit decimal number, including a 1-digit sign ("-" or, for a positive value a space). Any zeroes to the left of significant digits are output as spaces.



Usage example

```
      ⋮
100 PRINT#1,"=";CHR$(13);CHR$(10);
      ⋮
    PRINT#1,"["
    INPUT#1,X,Y
    PRINT X,Y            (X, Y):   Coordinates of LOWER
    PRINT#1,"U"                    LEFT
    INPUT#1,X,Y
    PRINT X,Y            (X, Y):   Coordinates of UPPER
      ⋮                            RIGHT
```

V READ STATUS WORD 1 command: Read-in of status

Command symbol V

Function Outputs the plotter status to the computer.

Input format V

Statement example PRINT #1, "V";

Output format Data output from plotter

s (terminator)

Parameter definitions s: Plotter status, 5 digits

When this 5-digit decimal number is expressed in binary format, each bit has the following meaning:

MSB	15	14	13	12	11	10	9	…	3	2	1	0
	0	0	0	E	0	←		B SPACE				→

B SPACE: Indicates how much more data can be stored in the buffer of the plotter's interface.

The data quantity units are bytes.

E: This bit becomes 1 (ON) if there is an error in the data received up to the execution of this command.

Description This command outputs to the computer the status of the plotter, and the buffer space available in the interface.

When this command is executed, the plotter outputs the status data to the computer immediately it receives it. (Direct command)

This means that the computer can monitor the status of the plotter and the remaining interface buffer space at the time this command was output to the plotter. It is possible to control the buffer by using this command when the buffer control provided by hardware (using the ER signal) or X on/X off switching is disabled.

The data output from the plotter is a 5-digit decimal number. Any zeroes to the left of significant digits are output as spaces.

$\underbrace{\sqcup\sqcup\sqcup\sqcup\sqcup}_{S}$ (Terminator)

Usage example

```
100 PRINT#1, "=";CHR$(13);CHR$(10);
110 PRINT#1, "V";
120 INPUT#1,S          No CR, LF output
130 B=MOD(S,2048)
140 E=MOD(S/4096,8192)
150 PRINT B,E          ← B: Buffer space    E: Error status
160 IF E<>0 THEN [Error handling]
170 IF B>200 THEN 200
180 A few seconds WAIT
190 GO TO 110
200    / Command output
```

@	READ STATUS WORD 2 command: Read-in of plotter status

Command symbol @

Function Outputs the plotter status to the computer

Input format @

Statement example PRINT#1, "@"

Output format Data output from plotter

s (terminator)

Parameter definition s: Plotter status, 5 digits

When this 5-digit decimal number is expressed in binary format, each bit has the following meaning:

MSB				4	3	2	1	0 LSB
					MY	PY	MX	PX

PX: 1 when a command which off-scales in the +X direction of the plotting area is given.

MX: 1 when a command which off-scales in the -X direction of the plotting area is given.

PY: 1 when a command which off-scales in the +Y direction of the plotting area is given.

MY: 1 when a command which off-scales in the -Y direction of the plotting area is given.

Description This command is stored temporarily in the buffer when it is received, and, when it is taken from the buffer, it outputs the status of the plotter to the computer.

It is possible to use this command to determine whether or not a given pen position (imaginary position which would move the pen out of the valid plotting area) is within the valid plotting area. The data output from the plotter is a 5-digit decimal number.

Any zeroes to the left of significant digits are output as spaces.

$\underbrace{\sqcup\sqcup\sqcup\sqcup\sqcup}_{S}$ (Terminator)

Usage example

```
      /
100 PRINT#1,"=";CHR$(13);CHR$(10);
      /
    PRINT#1,"@";
    INPUT#1,S
    PRINT S
      /
```

S: Plotter status

S = 0: Within plotting area
= 1: Off-scale in +X direction
= 2: Off-scale in -X direction
= 4: Off-scale in +Y direction
= 5: Off-scale in +X, +Y directions
= 6: Off-scale in -X, +Y directions
= 8: Off-scale in -Y direction
= 9: Off-scale in +X, -Y directions
= 10: Off-scale in -X, -Y directions

READ STATUS WORD 3 command: Read-in of error status

Command symbol #

Function Outputs information on the plotter's error status to the computer.

Input format #

Statement example PRINT#1, "#"

Output format Data output from the plotter
s (terminator)

Parameter definitions s: Plotter error information, 1 digit
When s = 0: No error
= 1: Command error
= 2: Terminator error
= 3: Delimiter error
= 4: Parameter overflow
= 5: I/O error
= 6: Overscale

These statuses are indicated in steps of 1, 2, 3, 4 ...., and are expressed in descending order of priority, with 1 having the highest priority. Therefore, when both command error and parameter overflow are generated, s = 1 is output.

Description This command outputs error information on the plotter to the computer.

When this command is executed, the plotter outputs status data to the computer as soon as it receives the command. (Direct command)

However, if the remaining buffer space in the plotter's interface is 255 bytes or less, the plotter waits until it becomes 256 or more before outputting the status data to the computer.

This function prevents the buffer filling up.

The error information is valid only with respect to errors whose error masks are released by the ERROR MASK command.

Error data is cleared when the READ STATUS WORD 3 command is executed. If this command is executed when there is more than one error, the error information is output in succession, starting with the smallest number. This means that all the error information can be posted, even when there are several errors.

The data output from the plotter is a 1-digit decimal number.

$\underset{S}{\sqcup}$ terminator

Usage example

```
      ⁄
100 PRINT#1, "=";CHR$(13);CHR$(10);
110 PRINT#1., "#";
120 INPUT#1,S
130 PRINT S          S:    Error status
      ⁄
```

DP	DRAW POLAR command:	Straight-line drawing in polar coordinate system

Command symbol DP (uppercase letters)

Function Draws a straight line starting from the current pen position, in the polar system set by the "↑P" command.

Input format DP r_1, θ_1, r_2, θ_2 ...... r_n, θ_n (terminator)

Statement example LPRINT "DP 300,450 " ;CHR$(3)

This draws a straight line from the current pen position to the position 300 units away at 45°, from the polar origin.

Parameter definitions
r: Distance from the polar origin (set by the "↑P" command). (Integral multiple of GDU)

θ: Angle from the angle reference (0° direction) set by parameter θ_0 of the "↑P" command, as seen from the polar origin (integral multiple of the angle unit defined by parameter f of the "↑P" command).

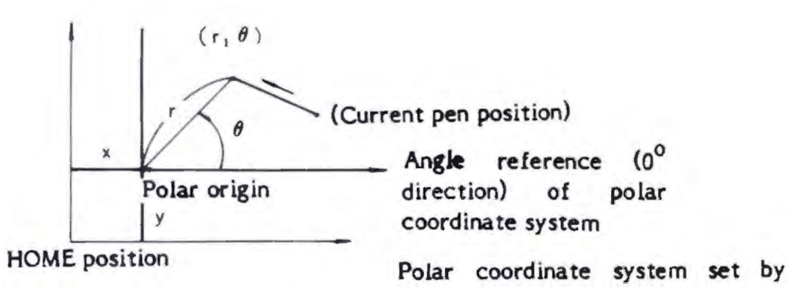


Fig. 7-10-1

Parameter ranges	$-32767 \leqq r \leqq 32767$ $-32767 \leqq \theta \leqq 32767$
Related commands	↑P , ↑ , / , L , B

Description

This command draws a straight line starting from the current pen position (r_0, θ_0), and connecting in succession the specified polar coordinates (r_1, θ_2), (r_2, θ_2), ... (r_n, θ_n), in the polar coordinate system set by the "↑P" command.

Parameters r and θ are the distance and angle, respectively, from the polar origin set by the "↑P" command.

Parameter r is valid as an integer within the range of -16383 to 16383. Any decimal point and decimal fraction are truncated.

Express θ as an integral multiple of the angle unit set by parameter f of the "↑P" command. It is valid within the range of -32767 to 32767, measured positively in the counterclockwise direction from the angle reference set by parameter θ_0 of the "↑P" command.

When a parameter is outside the specified range, or when no parameters are given, or when parameters do not form a (r, θ) pair, it is handled as an error.

If a specified pair of coordinates is outside the valid plotting area, the pen draws the line up to the edge of the valid plotting area, stops there, and rises.

EP	RELATIVE DRAW POLAR command:	Straight-line drawing between relative polar coordinates

Command symbol EP

Function

Draws a straight line from the current pen position to the coordinate point given by a displacement $\triangle r$ and an angular difference $\triangle \theta$, in the polar coordinate system set by the "↑P" command.

Input format

$EP \triangle r_1, \triangle \theta_1, \triangle r_2, \triangle \theta_2, \cdots\cdots, \triangle r_n, \triangle \theta_n$ (terminator)

Statement example

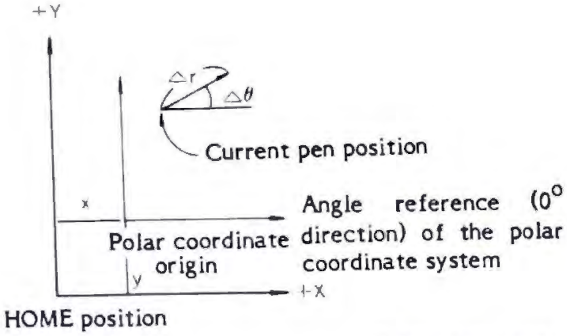
LPRINT "EP300,200";CHR$(3)

This draws a straight line from the current pen position to a point 30 mm (300) away at 20° (200).

Parameter definitions

$\triangle r$: Displacement (integral multiple of GDU)

$\triangle \theta$: The angle of the direction in which the pen moves from the angle reference (0° direction) in the polar coordinate system set by the "↑P" command. (Expressed as an integral multiple of the angle unit set by parameter f of the "↑P" command, measured positively in the counterclockwise direction).



Polar coordinate system set by "↑P x, y"

Fig. 7-10-2

Parameter ranges	$-16383 \leq \triangle r \leq 16383$ $-32767 \leq \triangle \theta \leq 32767$
Related commands	↑P , ↑[illegible] , [illegible] , L , B

Description

This command draws a straight line from the current pen position (r_0, θ_0) to the coordinate point given by the displacement $\triangle r$ and angular difference $\triangle\theta$, in the relative coordinate system specified by the "↑P command. When more than one point is given, the line connects in succession the points which are specified as ($\triangle r$, $\triangle\theta$) with respect to the previous point.

Express each parameter $\triangle r$ as an integral multiple of GDU, valid within the range of -16383 to 16383. Any decimal point and decimal fraction are truncated.

Express each $\triangle\theta$ as an integral multiple of the angle unit set by parameter f of the "↑P" command, valid within the range of -32767 to +32767. It is measured positively in the counterclockwise direction from the angle reference (0° direction) specified by parameter θ_0 of the "↑P" command.

When a parameter is outside the specified range, or when no parameters are given, or when parameters do not form a (r, θ) pair, it is handled as an error.

If a specified pair of coordinates is outside the valid plotting area, the pen draws the line up to the edge of the valid plotting area, stops there, and rises.

MP	MOVE POLAR command:	Movement of raised pen in polar coordinate system

Command symbol MP

Function Moves the raised pen from its current position to the point specified by a distance p and angle θ in the polar coordinate system set by the "↑P" command.

Input format MP r, θ (terminator)

Statement example LPRINT "MP500,450" ;CHR$(3)
This moves the raised pen from the current position to the position 500 units away at 45° from the polar origin.

Parameter definitions
r: Distance from the polar origin (set by "↑P"). (Integral multiple of GDU)
θ: Angle from the angle reference (0° direction) set by parameter θ_0 of the "↑P" command. (Integral multiple of the angle unit set by parameter f of the "↑P" command, measured positively in the counterclockwise direction.)

Parameter ranges
$-16383 \leqq r \leqq 16383$
$-32767 \leqq \theta \leqq 32767$

Related commands ↑P, ↑, SP, /, L, B

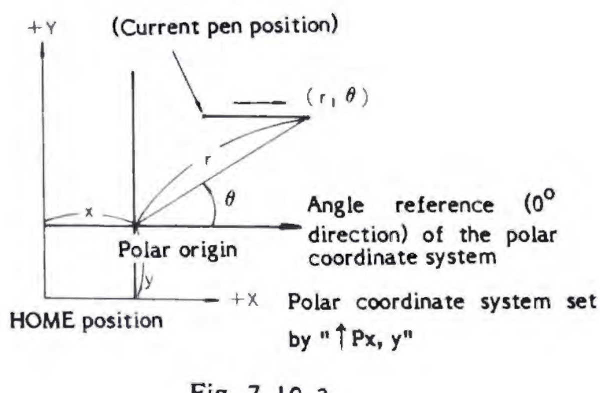


Fig. 7-10-3

Description

This command moves the raised pen from its current position to the point specified by the distance r and angle θ in the polar coordinate system set by the "↑P" command.

Parameters r and θ give the distance and angle from the origin of the polar coordinate system set by the "↑P" command.

Parameter r is valid within the range of -16383 to 16383; any decimal point and decimal fraction are truncated.

Express θ as an integral multiple of the angle unit set by parameter f of the "↑P" command. It is valid within the range of -32767 to 32767, measured positively in the counterclockwise direction from the angle reference set by parameter θ_0 of the "↑P" command.

If a series of "MP" commands is input, the pen does not move to each point, it moves directly to the point determined to be the final point by the succession of MOVE POLARs.

If a specified pair of (r, θ) coordinates is outside the valid plotting area, the pen stops at the edge of the valid plotting area.

OP	RELATIVE MOVE POLAR command:	Relative movement of raised pen in polar coordinate system

Command symbol OP (uppercase letters)

Function Moves the raised pen to the point given by a displacement △r and angular difference △θ from the current pen position, in the polar coordinate system set by the " ↑P command.

Input format OP △r , △θ (terminator)

Statement example LPRINT "OP 300, 450 " ; CHR $(3)

This moves the raised pen from its current position to a point 30 mm away at 45°

Parameter definitions △r: Displacement (integral multiple of GDU)

△θ: The angle of the pen movement from the angle reference (0° direction) of the polar coordinate system set by the " ↑P command. (Integral multiple of the angle unit set by parameter f of the " ↑P" command, measured positively in the counterclockwise direction.)

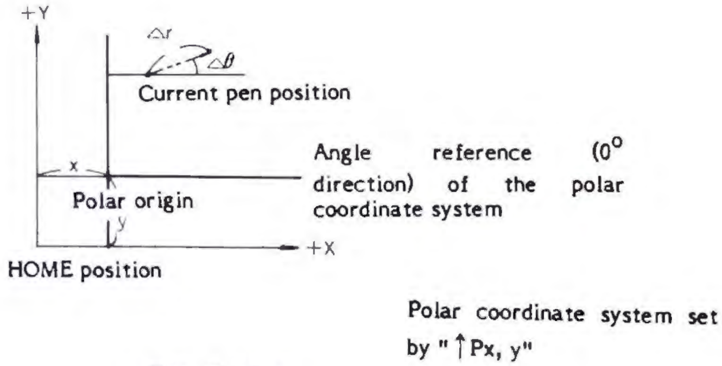


Fig. 7-10-4

Parameter ranges	$-16383 \leqq \Delta r \leqq 16383$ $-32767 \leqq \Delta\theta \leqq 32767$
Related commands	↑P , ↑ , ⁄ , L , B

Description

This command moves the raised pen to the coordinate point specified by the displacement Δr and angular difference $\Delta\theta$ from the current pen position (r_0, θ_0), in the polar coordinate system set by the "↑P" command.

Parameter Δr is valid within the range of -16383 to 16383; express it as an integral multiple of the GDU. Any decimal point and decimal fraction are truncated.

Express $\Delta\theta$ as an integral multiple of the angle unit set by parameter f of the "↑P" command. It is valid within the range of -32767 to 32767 and is measured positively in the counterclockwise direction from the angle reference (0° direction) set by parameter θ_0 of the "↑P" command.

If a series of "OP" commands is input, the pen does not move to each point, it moves directly to the point determined to be the final point by the series of "OP" commands.

When a parameter is outside the specified range, or when no parameters are specified, or when only one parameter is given, the plotter handles this as an error.

If a specified pair of coordinates is outside the valid plotting area, the pen moves to the edge of the plotting area and stops.

RP	RADIUS PLOT command: Radial plotting

Command symbol RP

Function

Draws a straight line segment of a specified length, in the direction of the angle θ from the origin of the polar coordinate system set by the "↑P" command. By making the center of a circle the polar origin, you can easily draw partition lines or pointers.

Input format

RP θ , ℓ_1 , ℓ_2 (terminator)

Statement example

LPRINT "RP300,250,1000" ;CHR$(3)

This draws a line segment of 25 mm (250) in the 30° (300) direction, starting from a point 100 mm (1000) away from the polar origin.

Parameter definitions

θ: Angle from the angle reference (0° direction) set by parameter θ_0 of the "↑P" command. (Expressed as an integral multiple of the angle unit set by parameter f of the "↑P" command, measured positively in the counterclockwise direction.)

ℓ_2: Distance from the polar origin to the start of the line (integral multiple of GDU).

ℓ_1: Length of the line segment from ℓ_2.

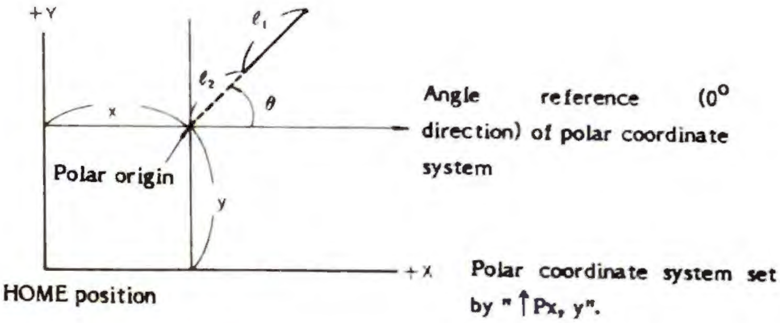


Fig. 7-10-5

Parameter ranges	$-32767 \leq \theta \leq 32767$	
	$-16383 \leq \ell_1 \leq 16383$	$\lvert \ell_1 - \ell_2 \rvert \leq 16383$
	$-16383 \leq \ell_2 \leq 16383$	
Related commands	↑P , ↑ , /	

Description

This command draws a straight line segment of the specified length ℓ_1 in the direction θ, starting from a point at a distance of ℓ_2 from the origin of the polar coordinate system set by the "↑P" command.

Parameter θ represents the angle when the polar origin is taken as the center. Express it as an integral multiple of the angle unit set by parameter f of the "↑P" command, measured positively in counterclockwise direction from the angle reference (0°) set by parameter θ_0 of the "↑P" command.

Parameter ℓ_2 specifies the start point of the straight line segment, and parameter ℓ_1 specifies the length of the line.

When the value of parameter ℓ_1 is a positive number, the line is drawn away from the origin, starting from the point specified by ℓ_2. This enables you to draw pointers for circular graphs, for example.

When parameter ℓ_1 is negative, the line is drawn towards the origin, so you can use this to draw partition lines in a circle, for example.

Both ℓ_1 and ℓ_2 are valid within the range of -16383 to 16383; any decimal points and decimal fractions will be truncated.

↑P	OFFSET POLAR command:	Setting of origin of polar coordinate system

Command symbol ↑P (" ↑ " is " [illegible] " in the JIS code.)

Function Sets the origin of the polar coordinate system.

Input format ↑P x, y, θ, f (terminator)

Statement example LPRINT"↑P1000,1000,900,-100";CHR$ [illegible]

This rotates through 90° the coordinate system whose polar origin is set at (1000, 1000).

The angle unit of the polar coordínate system is set as 3.6°, and angles are measured positively in the counterclockwise direction.

Parameter definitions

x, y: Distances from the coordinate origin (or the OFFSET point when OFFSET is executed) (Integral multiples of GDU)

θ: Angle of inclination from the angle reference (0° direction), measured with respect to the +X-axis direction (or the specified rotation angle when ROTATE is executed). (Integral multiple of 0.1°, measured positively in the counterclockwise direction)

Can be omitted

f: Number of divisions of angle (The entire circumference of 360° is expressed as an integer set by f. Angles are measured positively in the counterclockwise direction, but can be measured positively in the clockwise direction if this value is made negative.) All subsequent commands relating to the polar coordinate system are affected by this setting.

This also sets the angle unit for parameter θ of the polar coordinate commands "DP", "MP", "RP", "EP", and "OP".

Parameter ranges

$-16383 \leqq x, y \leqq 16383$

$-32767 \leqq \theta_0 \leqq 32767$ Default value is 0

$-32767 \leqq f \leqq 32767$ Default value is 3600

Related commands

DP , MP , OP , EP , % , RP

Description

This command sets the origin of the polar coordinate system used by the other polar coordinate commands "MP", "DP", "OP", "EP", and "RP".

(If the origin is not set, the OFFSET point becomes the origin.)

θ_0 is the angular difference between the 0° direction of the polar coordinate system and the 0° direction (+X direction) of the absolute coordinate system (or the specified rotation angle when ROTATE is executed), measured positively in the counterclockwise direction and expressed as an integral multiple of 0.1°.

You can omit this parameter; if it is omitted, the plotter assumes a value of 0.

Parameter f gives the number of divisions of the entire circumference (360°), and sets the minimum unit for parameter θ of the "MP", "EP", "DP", "OP", and "RP" commands.

Specify an integer valid within the range of -32767 to 32767 (but not 0), measured positively in the counterclockwise direction. (0.1° is the programable limit, so the final resolution is 0.1° for all values from 3600 upward.)

If you set a negative value for this parameter, all angles in the polar coordinate commands are measured positively in the clockwise direction. Only parameter θ_0 of the "↑P" command is not affected. Parameter f can also be omitted; if it is omitted, a value of 3600 is assumed.

When giving plotting data in which the clockwise direction is positive, make the number of divisions a negative number.

Examples When θ = 900 and f = -100:

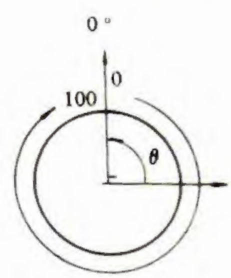


Fig. 7-10-6

The circumference is divided into 100 parts, with the 90° direction taken as 0°. (Angles are measured positively in the clockwise direction.)
(For a circular graph, θ = 1 now represents 1%.)

When θ_0 = 900, f = -6

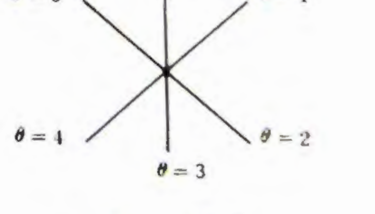


Fig. 7-10-7

The circumference is divided into 6 parts, with the 90° direction taken as 0°. (Angles are measured positively in the clockwise direction.)
(For a radar chart, θ can now be specified as each item number.)

7-11 Notes on the command functions

7-11-1 Initial settings

The initial setting of each command is shown in Table 7-11-1.

Table 7-11-1 Initial settings

Command	Parameter	Remarks
LINE TYPE	P = 0	Solid line
LINE SCALE	ℓ = 100	
WRITE LOWER LEFT	x = 0	HOME position
	y = 0	
WRITE UPPER RIGHT	x = 4000	
	y = 2850	
OFFSET	x = 0	HOME position
	y = 0	
OFFSET POLAR	x = 0	HOME position
	y = 0	
	θ_0 = 0	No rotation
	f = 3600	
FACTOR	p = 1	Magnification = 1
	q = 1	
	r = 1	
ALPHA SCALE	n = m = 30	
ALPHA SPACE	ℓ = 30	
	k = 0	
ALPHA ROTATE	θ = 0	No rotation
ALPHA ITALIC	p = 0	No tilting
FONT	n = 60	STANDARD codes (0 (zero) is slimmer than O (oh))
	m = 4	
LABEL POSITION	n = 1	

Command	Parameter	Remarks
SPEED	$\ell = 10$	Maximum plotting speed (depends on pen type)
NEW PEN	$n = 1$	
TERM	$t_1 = t_2 =$ (ETX)	
ERROR MASK	$m = 1$	Command error, I/O error
	$n = 0$	No service request
	$p = 0$	No response to parallel poll
ROTATE	$x = 0$	No rotation specification
	$y = 0$	
	$\theta = 0$	

7-11-2 The influence of commands

The plotting commands which are affected by other commands are listed below.

Table 7-11-2 Influence of commands

Commands with influence	Commands affected
ALPHA SCALE ALPHA SPACE ALPHA ITALIC ALPHA ROTATE ALPHA RESET	PRINT KANA (GREEK) MARK USER'S PATTERN USER'S PROGRAM PATTERN SELECT POINT MARK
LINE TYPE LINE SCALE	DRAW RELATIVE DRAW CURVE RELATIVE CURVE CIRCLE RELATIVE CIRCLE ELLIPSE DRAW POLAR RELATIVE DRAW POLAR RADIUS PLOT
SELECT POINT MARK	DRAW RELATIVE DRAW MOVE RELATIVE MOVE CURVE RELATIVE CURVE DRAW POLAR RELATIVE DRAW POLAR MOVE POLAR RELATIVE MOVE POLAR RADIUS PLOT

Table 7-11-2 Influence of commands

Commands with influence	Commands affected
OFFSET POLAR	DRAW POLAR RELATIVE DRAW POLAR MOVE POLAR RELATIVE MOVE POLAR RADIUS PLOT
LABEL POSITION	PRINT KANA(GREEK)
FACTOR ROTATE	All commands except for OFFSET, UR, LL
CLIPPING	All plotting commands
Commands with influence	**Commands partly affected**
LINE TYPE LINE SCALE	HATCHING (Frame lines only)
OFFSET POLAR	HATCHING (Angle of hatching lines and angles setting the drawing range of circular hatching.)

7-11-3 Direct commands

READ STATUS WORD 1, READ STATUS WORD 3, CLEAR, and INTERFACE CLEAR are direct commands which are executed immediately they are received. The other commands are performed in the order they have been stored in the buffer.

7-11-4 Plotting area and off-scale controls

The plotting area is the area set by WRITE LOWER LEFT and WRITE UPPER RIGHT. When a program tries to plot outside that area, drawing outside the area is prevented. Drawing outside the physically valid plotting area is prevented as well, even if a plotting area which exceeds it has been defined. These are the off-scale controls.

If a plotting command such as that shown in Fig. 7-11-4 is given to draw a line along P1 → P2 → P3 → P4, the actual movements of the pen are:

P1 → A (pen down)
A → B (pen up)
B → P4 (pen down)

A line is drawn only between P1 → A and B → P4. No distortion of plotting positions is caused by off-scale.

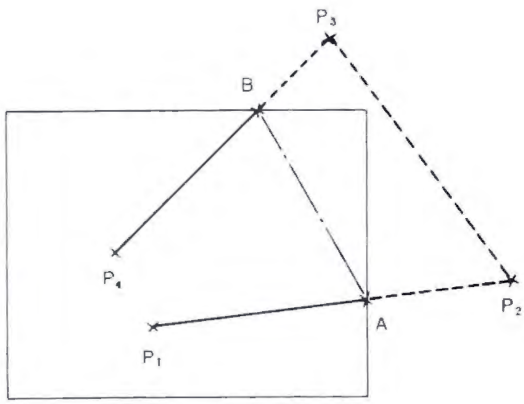


Fig. 7-11-4 Off-scale control

7-11-5 Handling of errors

There are 5 main causes of errors:

a) Data error:

Errors in the format, etc., of the input data. These occur if, for example, the x coordinate is given but not the y coordinate, or a terminator is omitted although one is necessary, etc.

When such an error occurs, the corresponding ERROR bit becomes 1 (ALARM lamp lights), and commands are temporarily inhibited, except for direct commands. (This can be masked by an ERROR MASK command.)

These errors are further divided into the following 4 types:

- o Command error
  When a code between $(60)_{16}$ and $(7E)_{16}$ has been handled as a command character.

- o Terminator error
  When there are not enough parameters.
  When a terminator wasn't added when one was necessary.

- o Delimiter error
  When a delimiter was omitted or when an undefined character was handled as a delimiter.

- o Parameter overflow
  When a numerical value exceeding the range of -32767 to +32767 or a coordinate value exceeding 2^{14} (16384) was handled as a parameter.

b) I/O error

Error relating to data reception in the interface unit. Errors in data transmission (e. g. when there is no listener when about to output

data specified by talker, etc.) with the GP-IB interface, or parity, framing, overrun errors in the RS-232-C interface fall within this category.

c) Off-scale

When data instructing plotting outside the valid area is handled, the ALARM lamp on the control panel lights and the off-scale error status bit becomes 1.

When data instructing a return to the valid plotting area is handled, the ALARM lamp goes out and the off-scale bit becomes 0.

d) Error clearance

Errors are cleared by the following means. The status of the ERROR bits is 0 when the corresponding errors are cleared.

I) Execute a READ STATUS WORD 1 or READ STATUS WORD 3 command.
II) Press ENTER (only data format errors cleared).
III) Initialize the plotter.
IV) Execute an INTERFACE CLEAR command.

Note: If I) and II) are done when the execution of the next command has been temporarily inhibited by a data format error, that command will be executed. III) and IV) clear the data within the buffer memory.

8. INTERFACE FUNCTIONS

8-1 Interfaces for MP2300

Three types of interfaces are provided for connecting the MP2300 to various computers: RS-232-C, GP-IB, and Centronics interfaces.

The interface plays a very important role in the exchange of data between a computer and external equipment (the plotter in this case).

Before connecting the plotter to a computer, it is necessary to set the same interface functions for both the computer and the plotter.

If there is a mistake in the interface setting, the plotter may not function at all, or it may function incorrectly. Carefully read the following descriptions of the interface settings before making the connection.

(Section 5-2 gives examples of setting the computer and plotter for reference.)

8-2 GP-IB interface

GP-IB is a bus line which uses a byte-serial, bit-parallel transmission method (in other words, data is sent 1 byte at a time). The main characteristic of this interface is that it controls the exchange of data on the bus line between each of the devices by three data transmission control lines, using an asynchronous confirmation method.

This asynchronous confirmation method is called a 3-wire handshake, and is the most distinctive feature of this bus. (IEEE-488 standard)

8-2-1 GP-IP interface functions

The functions of the GP-IB interface are given below.

AH-1	Reception handshake function present
SH-1	Transmission handshake function present
T-6	Basic talker function present; talker-only absent
L-3	Basic listener, listener-only mode, and listener exclusion by MTA (My Talk Address) functions present
SR-0	Service request function absent
RL-0	All RL functions absent
PP-0	Parallel polling function absent
DC-1	All device clear functions present
DT-0	Device trigger function absent
C-0	Controller function absent

- Connectors: Plotter end 57-20240 (DDK)
  Cable end 57-10240 (DDK)

- Electrical characteristics
  The levels are based on standard TTL levels, with the following logic states:
  Logical 0: +2.4V or more
  Logical 1: +0.8V or less

- Buffer memory 6 Kbytes

Fig. 8-1 shows the connector on the interface unit, as seen from the rear.

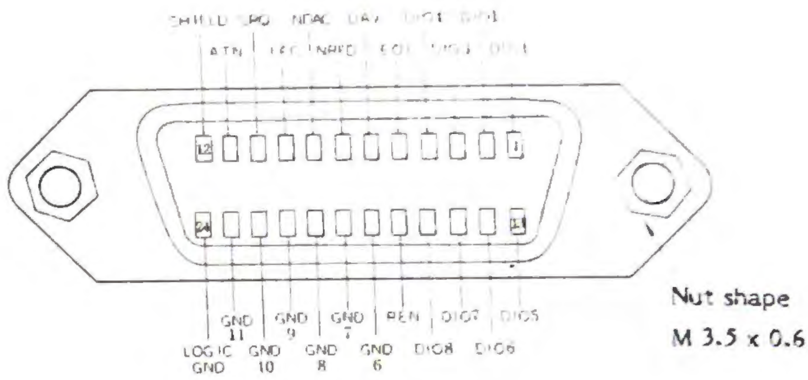


Fig. 8-1 GP-IB connector

8-2-2 Switch setting of GP-IB interface

The GP-IB interface switches are located on the rear panel of the MP2300. These switches set the data conditions for transmission between plotter and computer.

Set these switches before connecting the MP2300 to the computer.

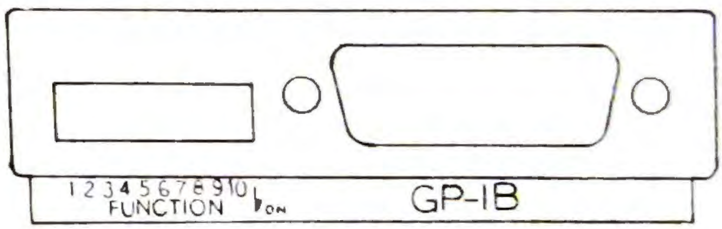


Fig. 8-2 Rear panel of MP2300-11

Function-setting switches

BIT No.	1	2	3	4	5	6	7	8	9	10
Setting	GP-IB address					Address mode	EOI processing	—	—	—
OFF	See the table of MLA/MTA settings					Listen only	EOI effective	Always	Always	Always
ON						Address effective	EOI ignored	Do not use	Do not use	Do not use

Bits 1 to 5

These set the GP-IB address. The address set by bits 1 to 5 is effective only when bit 6 is at ON.

Bit 6

Sets the address mode.

OFF: Listen only

ON: Address effective (set by bits 1 to 5)

In listen-only mode, all data is effective, regardless of address; it is not possible to send data from the plotter.

Bit 7

Sets the EOI (End-Of-Identity) function for GP-IB.

OFF: EOI is effective.

ON: EOI is not effective.

Note: When bit 7 is at OFF, EOI is effective and the system operates as if it has received a terminator.

Bits 8 to 10

Keep these switches always at OFF.

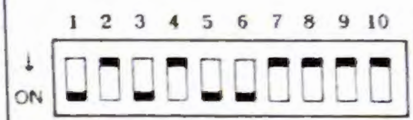
No.	(MSB) 1	2	3	4	(LSB) 5
Operation	2^4	2^3	2^2	2^1	2^0

MLA/MTA			S 1				
Address code	MLA character	MTA character	1	2	3	4	5
0	SP	@	0	0	0	0	0
1	!	A	0	0	0	0	1
2	"	B	0	0	0	1	0
3	#	C	0	0	0	1	1
4	$	D	0	0	1	0	0
5	%	E	0	0	1	0	1
6	&	F	0	0	1	1	0
7	'	G	0	0	1	1	1
8	(	H	0	1	0	0	0
9	)	I	0	1	0	0	1
10	*	J	0	1	0	1	0
11	+	K	0	1	0	1	1
12	,	L	0	1	1	0	0
13	−	M	0	1	1	0	1
14	.	N	0	1	1	1	0
15	/	O	0	1	1	1	1
16	0	P	1	0	0	0	0
17	1	Q	1	0	0	0	1
18	2	R	1	0	0	1	0
19	3	S	1	0	0	1	1
20	4	T	1	1	1	0	0
21	5	U	1	1	1	0	1
22	6	V	1	1	1	1	0
23	7	W	1	1	1	1	1
24	8	X	1	0	0	0	0
25	9	Y	1	0	0	0	1
26	:	Z	1	0	0	1	0
27	;	[	1	0	0	1	1
28	<	\	1	1	1	0	0
29	=	]	1	1	1	0	1
30	>	↑	1	1	1	1	0

Table of MLA/MTA settings

Example of address setting

The setting below gives:
Address: 10
Address effective
EOI effective



* Each address switch indicates 1 when at OFF, and 0 when at ON.

Note: The address setting is done only once, when power is turned on. Therefore, to reset the address, turn the power off and on again.

8-3 RS-232-C interface

The RS-232-C interface of the MP2300 is an interface which uses a serial transmission method conforming to the EIA (Electronic Industry Association of U. S. A.) standards.

This interface transmits digital binary serial data, control signals, and timing signals.

8-3-1 RS-232-C interface functions

General specifications

o	Standards	CCITT V24, EIA RS-232-C, JIS C6361
o	Transmission method	Asynchronous, start-stop synchronization
o	Transmission speeds	300, 600, 1200, 2400, 4800, 9600 baud (switch selectable)
o	Stop bit	1- or 2-bit methods (switch selectable)
o	Parity	Even, odd, or none (switch selectable)
o	Data length	7 bits or 8 bits (switch selectable)

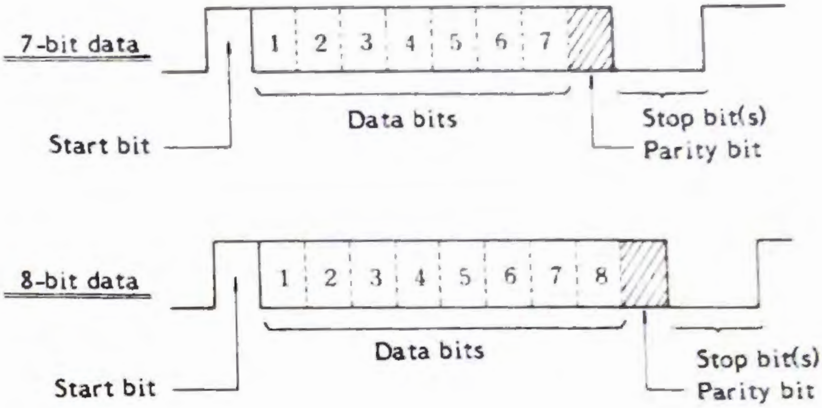


Fig. 8-3-1

- Electrical characteristics

			RD, SD (Negative logic)	RS, CS, DR, ER (Positive logic)
o	Input voltage levels	+5V to +12V	Logical 0	ON
		-5V to -12V	Logical 1	OFF
o	Output voltage levels	+5V to +8V	Logical 0	ON
		-5V to -8V	Logical 1	OFF

- RS-232-C connector pin arrangement

Signal symbol	Signal abbreviation	RS-232-C	CCITT V-24	Signal direction	Signal name	Function
1	FG	AA	101	—	PROTECTIVE GROUND	
2	SD	BA (TDATA)	103	←P	TRANSMITTED DATA	Data output from plotter
3	RD	BB (RDATA)	104	→P	RECEIVED DATA	Data input to plotter
4	RS	CA (RTS)	105	←P	REQUEST TO SEND	ON when the plotter is sending. (Note 1)
5	CS	(CTS)	106	→P	CLEAR TO SEND	The plotter transmits data when this signal is ON.
6	DR	(DSR)	107			Not used
7	SG	AB (SGND)	102	—	SIGNAL GROUND	Connected to the plotter's signal ground
8 ~ 19						Not used
20	ER	CD (DTR)	108.2	←P	DATA TERMINAL READY	ON when the plotter is able to receive data. (Note 2)
21 ~ 25						Not used

Note 1: The RS signal is specified by bit 3 of the rear-panel switches.

Note 2: The ER signal is always on when X on/X off handshake is selected by bit 2 of the DIP switches S2 on the base.

Note: ←P means output from the plotter; →P means input to the plotter.

Fig. 8-3-2 shows the interface connectors, as seen from the rear.

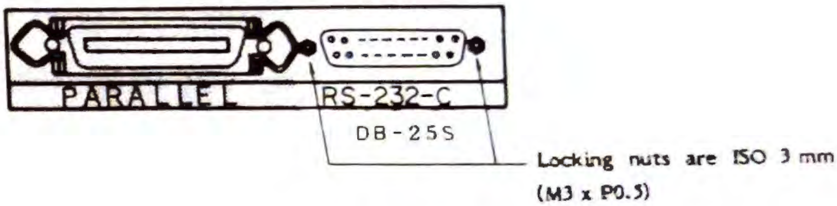


Fig. 8-3-2

. Buffer memory 6 Kbytes

8-3-2 Switch settings of RS-232-C interface

The RS-232-C interface switches are located on the base of the MP2300. These switches set the data transmission conditions.

Set these switches before connecting the plotter to the computer.

o Note that the settings of switches S2 and S3 are different for Graphtec commands and HP-GL emulation commands.

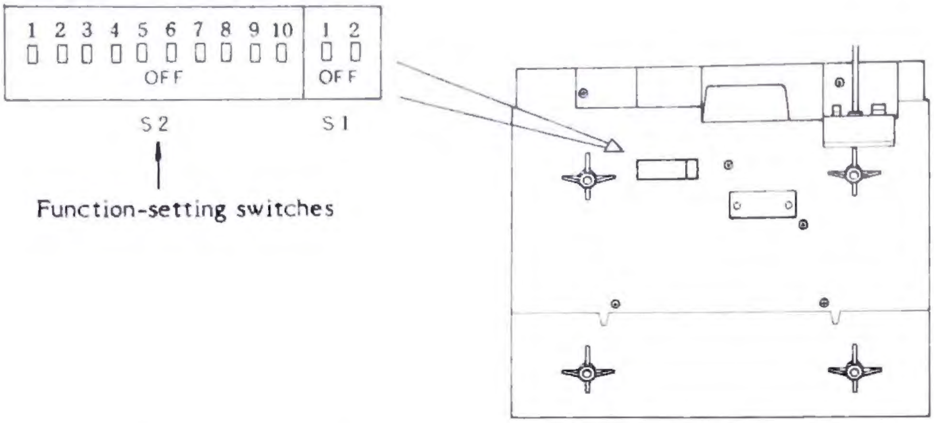


Fig. 8-3-3 RS-232-C switches on MP2300's base

Table 8-3 Function-setting switches S2

Table 8-3 Setting for Graphtec commands

BIT No.	1	2	3	4	5	6	7	8	9	10
Setting	I/F MODE	HAND-SHAKE	RS control	CHARACTER LENGTH	PARITY		STOP BIT	BAUD RATE		
ON	RS	Xon/Xoff HAND-SHAKE	Usually ON	8-BIT	Parity	EVEN	2-BIT			
OFF	CENTRO	HARD HAND-SHAKE	On only when transmitting	7-BIT	None	ODD	1-BIT			

Setting for HP/GL emulation commands

2	3
Ignores plotter off commands	The ESC command is also input to the buffer
Usually	Usually

Baud rate

	8	9	10
9600	ON	—	—
4800	—	ON	—
2400	ON	ON	—
1200	—	—	ON
600	ON	—	ON
300	—	ON	ON

- means OFF

Note:	Set the switches before turning the power on.

o Switch settings for Graphtec commands

Bit 1

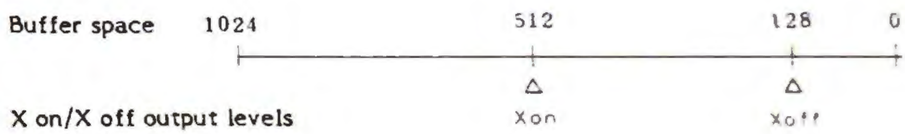
Always set to ON.

Bit 2

OFF: Provides buffer control using the ER (DATA TERMINAL READY) signal. ER-ON indicates that there is space in the buffer, and ER-OFF indicates that the buffer is full.

ON: Provides buffer control using X on (DC1)/X off (DC3) characters.

X off is output when the remaining buffer space falls to 128 bytes or less. X on is output when the space reaches 512 bytes or more.



Bit 3

This specifies control of the RS (REQUEST TO SEND) signal.

OFF: Turns the RS signal ON only while data is output from the plotter.

ON: Keeps the RS signal ON, regardless of data output.

Bit 4

This specifies whether the transmitted characters are 7 bits or 8 bits long.

OFF: 7-bit characters

ON: 8-bit characters

Bit 5

This specifies whether or not the parity bit is used.

OFF: Parity bit not used

ON: Parity bit used

Bit 6

When the use of the parity bit is specified by bit 5, this selects even or odd parity.

OFF: Odd parity

ON: Even parity

Bit 7

This selects 1 bit or 2 bits as the stop bit.

OFF: Stop bit is 1 bit.

ON: Stop bit is 2 bits.

Bits 8 to 10

These select the transmission speed (baud rate).

See Table 8-3.

- Switch settings for HP-GL commands

Bit 1

Always set to ON.

Bit 2

ON: This ignores the plotter commands ESC.) and ESC.Z

Bit 3

ON: Also inputs interface control commands to the buffer. Can be used for checking the output of interface control commands.

Bit 4

This specifies whether the transmitted characters are 7 bits or 8 bits long.

OFF: 7-bit characters

ON: 8-bit characters

Bit 5

This specifies whether or not the parity bit is used.

OFF: Parity bit not used

ON: Parity bit used

Bit 6

When the use of the parity bit is specified by bit 5, this selects even or odd parity.

OFF: Odd parity

ON: Even parity

Bit 7

This specifies whether the stop bit is 1 bit or 2 bits.

OFF: Stop bit is 1 bit

ON: Stop bit is 2 bits

Bits 8 to 10

These select the data transmission speed (baud rate). (See Table 8-3-2.)

8-4 Centronics interface

This interface is mainly used for printers. It is activated by simply connecting a cable to the plotter, although it is necessary to set the interface mode to Centronics by turning off bit 1 of the 10-bit DIP switches S2.

The input data signal applies 8 bits of data to DB0 to DB7, then inputs the $\overline{\text{STROBE}}$ signal.

The MP2300 turns on the BUSY signal, reads the data while outputting the $\overline{\text{ACK}}$ signal, then starts plotting.

When the specified operation has ended, the plotter waits for the input of the next data.

If you are making your own input-output cable, make sure that it is less than 2 meters long.

8-4-1 Centronics interface functions

. General specifications

- o The Centronics interface cannot output data from the plotter. (READ commands and the GIN and CALL GIN commands cannot be used.)

- o Transmission method: Asynchronous transmission method by handshake of $\overline{\text{STROBE}}$ and BUSY signals.

. Electrical characteristics

The levels are standard TTL level with the following logic states:

Positive logic	1 is +2.4V or more 0 is +0.4V or less	DATA, BUSY
Negative logic	1 is +0.4V or less 0 is +2.4V or more	$\overline{\text{ERROR}}$ $\overline{\text{ACK}}$, $\overline{\text{STROBE}}$

- Input-output circuits

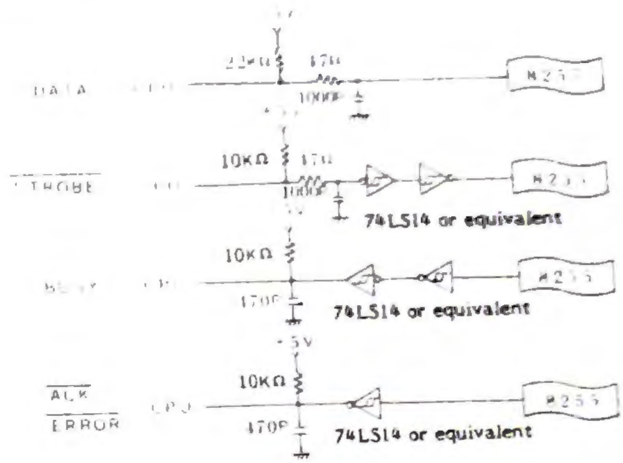


Fig. 8-4-1

- Input-output timing chart

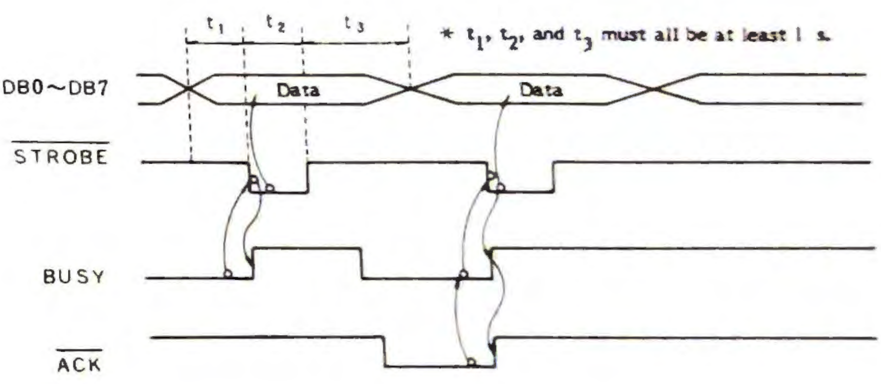


Fig. 8-4-2

- Buffer memory 6 Kbytes

- Connectors

  Plotter end JD-36SL-AL1 (Japan Aviation Electronics)

  Cable end 57-30360 (DDK)

- Input-output connector

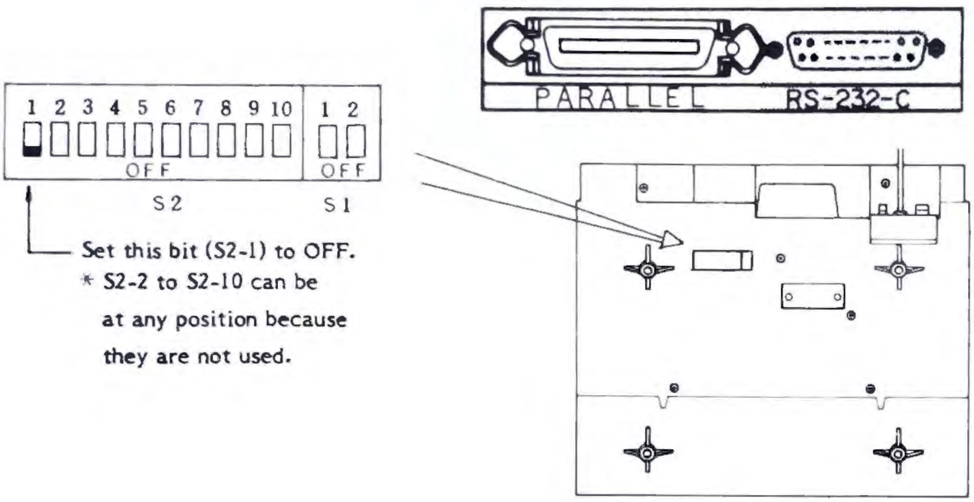


Fig. 8-4-3

- Connector pin arrangement

Pin No.	Signal line name	Pin No.	Signal line name
1	$\overline{\text{STROBE}}$	19	GND
2	DB 0	20	″
3	″ 1	21	″
4	″ 2	22	″
5	″ 3	23	″
6	″ 4	24	″
7	″ 5	25	″
8	″ 6	26	″
9	″ 7	27	″
10	$\overline{\text{ACK}}$	28	″
11	BUSY	29	″
12	GND	30	″
13	SLCT	31	NC
14	NC	32	$\overline{\text{ERROR}}$
15	″	33	GND
16	GND	34	NC
17	NC	35	″
18	″	36	″

9. SPECIFICATIONS

Valid plotting area	400 mm along X-axis, 285 mm along Y-axis
Maximum plotting speed	400 mm/sec (when pen is up) 250 mm/sec (when pen is down)
Mechanical resolution	0.05 mm
Programmable step size	0.1 mm
Distance accuracy	Within 0.3% of distance moved
Dynamic accuracy	Within 0.3 mm (P-P)
Repeatability	0.1 mm
Perpendicularity	Within 1 mm/285 mm
Pen change-over accuracy	Within 0.4 mm
Pen up/down frequency	15 times/sec (up is once, down is once)
Number of pens	8
Pen types	Water based ball-point pens (8 colors: red, black, blue, green, violet, brown, orange, and pink) Oil based fiber-tip pens (4 colors: red, black, blue, and green) Water based ball-point pens

	(4 colors: red, black, blue, and green)
	Ceramic pens
	(0.3 ϕ, 0.5 ϕ, 0.7 ϕ)
	Ink pens
	(0.2 ϕ, 0.3 ϕ, 0.4 ϕ, 0.5 ϕ, 0.6 ϕ, 0.8 ϕ)
Paper size	Up to 420 mm x 300 mm (A3 size)
Paper holding method	Electrostatic adhesion
Operating conditions	Temperature $+5^{\circ}C$ to $+35^{\circ}C$ Humidity 35% to 75% R.H.
Power supply conditions	100/120/200/220/240 VAC (Power supply selector) $\pm 10\%$ (50/60 Hz) Power consumption 45 VA or less
External dimensions	560 (W) x 440 (D) x 135 (H) mm
Weight	Approx. 6 Kg

10. COMMAND LISTS

10-1 Formats and functions of Graphtec commands (MP1000) (1)

Command	Format	Description
LINE TYPE	L p (T)	This specifies the type of straight line to be drawn. All the lines drawn after the receipt of this command will be solid lines when p = 0, and dotted lines when p = 1, until otherwise specified. If this command is not given after turning the power on, solid lines will be drawn by DRAW and RELATIVE DRAW commands. (Note 1)
LINE SCALE	B ℓ (T)	This specifies the pitch of broken lines. $\ell \leq 16383$. The lines and spaces are in the ratio of 1:1, the pitch will be twice as large as ℓ. (Initial setting is $\ell = 30$.) The specification is valid until a new one is given. This command can be given either before or after a LINE TYPE command. (Note 1)
DRAW	D x_1, y_1, x_2, y_2 ..... x_n, y_n (T)	This draws straight line segments connecting the absolute coordinates (x_0, y_0) (current pen position), (x_1, y_1), (x_2, y_2) ...... (x_n, y_n). The absolute coordinates are expressed as integral multiples of 0.1 mm. The coordinates (100, 100) indicate the position (X = 10 mm, Y = 10 mm) relative to the origin.
MOVE	M x, y (T)	This moves the raised pen from the current position (x_0, y_0) to the coordinates (x, y).

<table>
<tr><td>RELATIVE DRAW</td><td>I$\Delta x_1,\Delta y_1$
$\Delta x_2,\Delta y_2$,
......
$\Delta x_n,\Delta y_n$
(T)</td><td>This draws straight lines starting from the current pen position (x_0, y_0) and connecting in turn the relative displacements: $(x_0 +\Delta x_1, y_0 +\Delta y_1)$, $(x_0 +\Delta x_1 +\Delta x_2, y_0 +\Delta y_1 +\Delta y_2)$ ...... $(x_0 + \sum_{n=1}^{n} \Delta x_n, y_0 + \sum_{n=1}^{n} \Delta y_n)$. Δx_1 and Δy_1 are increments. (Expressed as integral multiples of 0.1 mm.)</td></tr>
<tr><td>RELATIVE MOVE</td><td>R$\Delta x,\Delta y$
(T)</td><td>This moves the raised pen from its current position (x_0, y_0) to $(x +\Delta x, y +\Delta y)$.</td></tr>
<tr><td>AXIS</td><td>X p, q, r
(T)</td><td>This draws a coordinate axis. p = 0 or 2 specify the Y-axis, p = 1 or 3 specify the X-axis. The meanings of q and r depend on the value of p as shown below.
<table>
<tr><td>p</td><td>Axis</td><td>q</td><td>r</td></tr>
<tr><td>0</td><td>Y</td><td>Unit length</td><td>Number of repeats</td></tr>
<tr><td>1</td><td>X</td><td>Unit length</td><td>Number of repeats</td></tr>
<tr><td>2</td><td>Y</td><td>Total length</td><td>Number of divisions</td></tr>
<tr><td>3</td><td>X</td><td>Total length</td><td>Number of divisions</td></tr>
</table>(Note 2)</td></tr>
<tr><td>HATCHING</td><td>%n, x, y,
d, θ (T)</td><td>This draws a rectangle parallel to the X- and Y- axes and also draws hatching.
n = 1:Rectangle only
n = 2:Hatching only
n = 3:Rectangle and internal hatching
(Note 3)</td></tr>
</table>

HOME	H (T)	This moves the raised pen to its power-on position. The operation is the same as that initiated by M 0, 0 (T), but if this command is executed when the ALARM lamp is on, the lamp will turn off, and the pen will return to its original position and wait for the next command.
ALPHA SCALE	S n (T)	This specifies the size of characters and marks. n is an integer between 0 and 254. When n = 0, characters of 0.7 x 0.4 mm are drawn with a spacing of 0.3 mm. When n = 14, the size of the characters is increased to (0.7 x 15 =) 10.5 mm x (0.4 x 15 =) 6 mm. The character spacing is also increased to (0.3 x 15=) 4.5 mm. Spaces are automatically increased as well. The specification of this command is valid until another ALPHA SCALE command is input. If this command is not given after turning the power on, n = 3 is specified automatically. The same applies to the printing of marks. When n = 0, marks of 0.4 mm x 0.4 mm are drawn. When n = 14, their size is increased to (0.4 x 15 =) 6 mm x (0.4 x 15 =) 6 mm. (Note 4)
ALPHA ROTATE	Q n (T)	This rotates the characters in the direction specified by n. n is an integer between 0 and 3, and specifies the following angles: When n = 0: 0° " n = 1: 90° " n = 2: 180° " n = 3: 270° This command can be given either before or after a Sn command. If this command is not

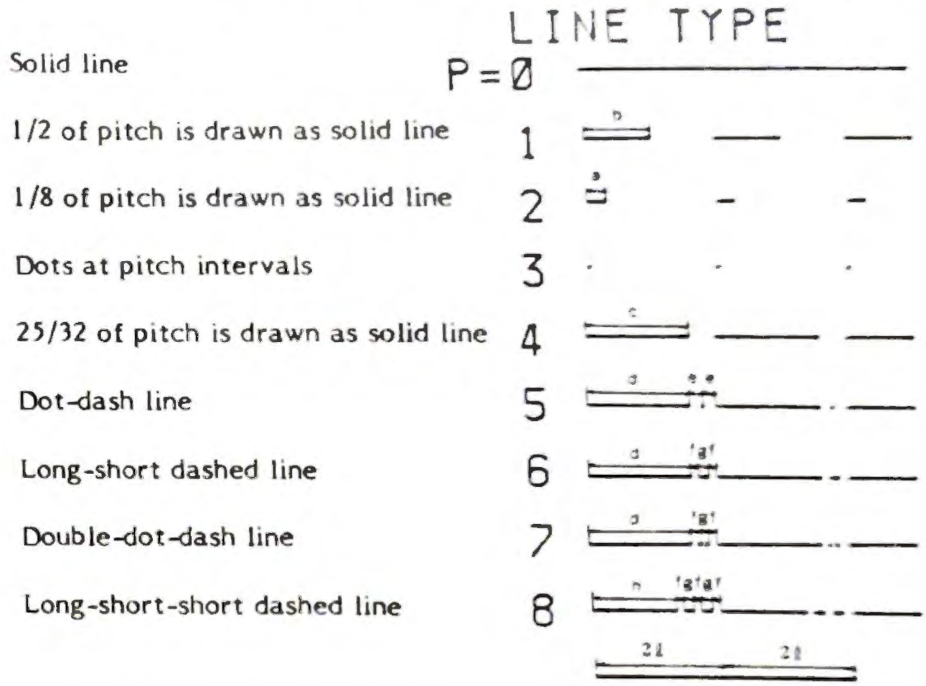
		given after turning the power on, n = 0 is specified automatically, in the same way as in a Sn command. This specification is valid until the next one is given.
ALPHA SPACE	On (T)	This specifies the spacing between one character or symbol and the next by n. (This command must be given immediately after an ALPHA SCALE command.)
CIRCLE	Wx_0, y_0, r_1, r_2, θ_1, θ_2 [, d] (T)	This draws a circle, arc or spiral (x_0, y_0): Coordinates of center (r_1, r_2): Initial and final radii (integral multiples of 0.1 mm) (θ_1, θ_2): Initial and final angles (integral multiples of 0.1°) (d): Specification of number of segments or angle subtended by segments of circle or circular arc. $0 < d$: Segment angle of circle or arc $0 > d$: Number of segments of circle or arc $0 = d$: Automatic division
RELATIVE CIRCLE	] r_1, r_2, θ_1, θ_2 [, d] (T)	This draws a circle, arc or spiral. (r_1, r_2): Initial and final radii (integral multiples of 0.1 mm) (θ_1, θ_2): Initial and final angles (integral multiples of 0.1°) (d): Specification of number of segments or angle subtended by segments of circle or arc. $0<d$: Segment angle of circle or arc. $0>d$: Number of segments of circle or arc $0 = d$: Automatic division

CURVE	Ya, x_1, y_1, x_2, y_2 ..... x_n, y_n (T)	This draws a smooth curve through the points with coordinates (x_1, y_1), (x_2, y_2) .... (x_n, y_n). a = 0:Open curve a = 1:Closed curve
RELATIVE CURVE	←a, $\triangle x_1$, $\triangle y_1$, $\triangle x_2$, $\triangle y_2$, ... $\triangle x_n$, $\triangle y_n$ (T)	This draws a smooth curve through the points specified by relative displacements. $(\triangle x_1, \triangle y_1)$: Relative displacements of the start of the curve from the current pen position $(\triangle x_2, \triangle y_2)$ .... $(\triangle x_n, \triangle y_n)$: Relative displacements of subsequent points of the curve a = 0:Open curve a = 1: Closed curve
ALPHA RESET	A (T)	This returns parameter settings relating to character and symbol drawing to their initial values. Initial setting (S command: n = 3, Q command: n = 0)
PRINT	P C_1 C_2 C_3 .... C_n (T)	This writes the characters specified by C_1 in succession. Codes other than 01 to 0D (hexadecimal) with no corresponding characters (e.g. DLE, NAK, SYN, ETB) are all ignored. However, a blank space is left instead of a space. There are a total of 95 characters available, including uppercase alphabetics, lowercase alphabetics and numerals. (Note 4)
KANA	K C_1 C_2 C_3 .... C_n (T)	This writes the katakana, hiragana and Greek characters specified by the codes C_1, C_2 .... C_n.

MARK	Nn (T)	This draws the special symbol (mark) specified by n, where n is an integer between 0 and 15. The size of the marks can be increased by an ALPHA SCALE command, except for the n = 0 mark. (Note 5)
NEW PEN	Jn (T)	This selects the pen specified by n, where n is an integer between 0 and 8. The initial setting is n = 1.
SPEED	T ℓ (T)	This sets the speed of the pen when down over 10 stages. $\ell = 0$ and $\ell = 10$ specify the maximum speed. The specified speed $V = \ell * 25/10$ (cm/s)
CLEAR	: (T)	This clears all the settings and moves the pen to the HOME position. The alarm is also cleared.
TERM	$= t_1\ t_2$ $[, t_3\ t_4]$	This specifies the terminators of the input and output data by $t_1\ t_2$, $t_3\ t_4$ (2 characters). $t_1\ t_2$: Terminators for data received $t_3\ t_4$: Terminators for data sent $t_3\ t_4$ can be omitted, when omitted the setting will be $t_3\ t_4 = t_1\ t_2$
READ STATUS 1	V (T)	This transmits the plotter status word 1 to the host machine. Transmission takes place as soon as this command is received.
READ STATUS 3	# (T)	This transmits the plotter status word 3 to the host machine. Transmission takes place if the remaining buffer space is at least 256 bytes when this command is received.
INTERFACE CLEAR	; (T)	This initializes the interface control. Any data remaining in the buffer is lost. This command is executed as soon as it is received.

Note 1: Pitch of broken lines:

Parameter ℓ of the B command specifies the pitch of broken lines. Its definition is shown in the figure below.



$a = \frac{1}{8}2\ell,\ b = \frac{1}{2}2\ell,\ c = \frac{25}{32}2\ell,\ d = \frac{25}{32}2\ell,\ e = \frac{7}{64}2\ell,\ f = \frac{5}{64}2\ell,\ g = \frac{4}{64}2\ell,\ h = \frac{41}{64}2\ell$

Fig. 10-1

Note 2: Plotting of coordinate axes:

When the command xp, q, r (LF) is given as x1, 150, 6, the axis shown below is drawn. The pen remains down at point F waiting for the next command.

Current pen position

Fig. 10-2

Note 3: Hatching:

x: Length in X-axis direction (integral multiple of 0.1 mm)

y: Length in Y-axis direction (integral multiple of 0.1 mm)

d: Spacing of hatching lines (integral multiple of 0.1 mm)

θ: Angle of hatching from X-axis (integral multiple of 0.1, measured positively in the counterclockwise direction and negatively in the clockwise direction)

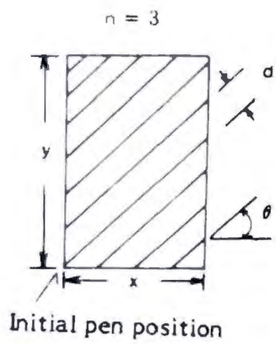


Fig. 10-3

Note 4: PRINT command

When a command such as PABCD .... (LF) is issued, the pen draws the character A starting at its current position, and then the characters B, C .... positioned as shown in Fig. 10-4. The height H of the characters can be increased by an ALPHA SCALE command, and the spacing between the characters can be specified by an ALPHA SPACE command. If no spacing specification is given, it will be set as shown in Fig. 10-4.

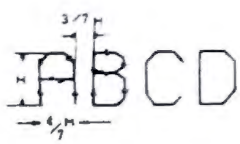


Fig. 10-4

Note 5: MARK command:

When Nn (LF) is input, marks are drawn centered on the current pen position. In the mark ⊠, the point at which

the two triangles touch is the current pen position. The end point of the drawing is the same as the start point. The pen will remain down at the end of the plotting. The size of the mark is as shown in Fig. 10-5, but it can be increased by an ALPHA SCALE command.

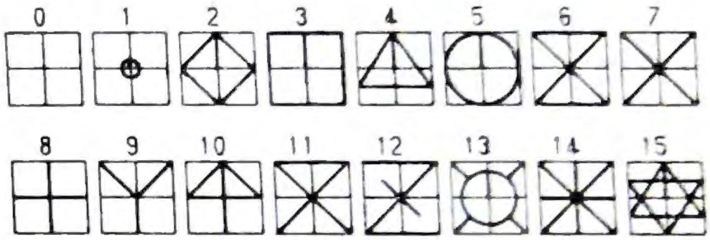


Fig. 10-5

10-2 Formats and functions of Graphtec commands (personal plotter) (2)

	Command	Data format	Function	Remarks
Straight line movements	DRAW	D x_1, y_1, x_2, y_2 .... x_n, y_n (t)	Draws straight line segments connecting the points $(x_1, y_1), (x_2, y_2)$ .... (x_n, y_n).	LINE TYPE and LINE SCALE settings are valid. For specification of (t) see the TERM command.
	RELATIVE DRAW	E$\triangle x_1, \triangle y_1, \triangle x_2, \triangle y_2$ .... $\triangle x_n, \triangle y_n$ (t)	Draws straight line segments with the relative displacements $(\triangle x_1, \triangle y_1)$, $(\triangle x_2, y_2)$ .... $(\triangle x_n, \triangle y_n)$.	
	MOVE	M x, y,	Moves the raised pen to coordinates (x, y).	
	RELATIVE MOVE	O$\triangle x, \triangle y$,	Moves the raised pen from its current position to the relative point $(\triangle x, \triangle y)$.	
	DRAW POLAR	D P $r_1, \theta_1, r_2, \theta_2$ .... r_n, θ_n (t)	Draws straight line segments connecting the points $(r_1, \theta_1), (r_2, \theta_2)$ .... (r_n, θ_n) in the polar coordinate system.	LINE TYPE and LINE SCALE settings are valid.
	RELATIVE DRAW POLAR	E P $\triangle r_1, \triangle\theta_1, \triangle r_2, \triangle\theta_2$ .... $\triangle r_n, \triangle\theta_n$ (t)	Draws straight line segments with the relative displacements $(\triangle r_1, \triangle\theta_1)$, $(\triangle r_2, \triangle\theta_2)$ .... $(\triangle r_n, \triangle\theta_n)$ in the polar coordinate system.	
	MOVE POLAR	M P r, θ (t)	Moves the raised pen to coordinates (r_1, θ) in the polar coordinate system.	

	RELATIVE MOVE POLAR	O P $\triangle r$, $\triangle \theta$ (T)	Moves the raised pen from its current pen position to the relative point ($\triangle r$, $\triangle \theta$) in the polar coordinate system.	
	RADIUS PLOT	R P θ, ℓ_1, ℓ_2	Draws a straight line with a length of ℓ_1, from (θ, ℓ_2) in the polar coordinate system.	LINE TYPE and LINE SCALE settings are valid.
Characters and symbols	PRINT	P c_1 c_2 .... c_n (t)	Writes the alphanumerics specified by the codes c_1, c_2 .... c_n. (See the code charts at the end of this manual)	ALPHA RESET, ALPHA SCALE, ALPHA SPACE, ALPHA ROTATE, and ALPHA ITALIC settings are valid.
	KANA (GREEK)	K c_1 c_2 .... c_n (t)	Writes the katakana characters and Greek characters specified by codes c_1, c_2 .... c_n. (See the code charts at the end of this manual)	
	MARK	N n,	Draws the symbol specified by n centered on the current pen position.	
	SELECT POINT MARK	SPc (t)	Draws one character or symbol specified by c centered on the end point of a straight line or a pen movement.	
	USER'S PROGRAM PATTERN	($P_{(p,)}$ $\triangle x$, $\triangle y_1$, (p,) $\triangle x_2$, $\triangle y_2$, ... (p,) $\triangle x_n$, $\triangle y_n$	Draws patterns specified by pen status p and pen displacements $\triangle x$, $\triangle y$.	

Circles, curves	CIRCLE	W x_0, y_0, r_1, r_2, θ_1, θ_2, [, d] (t)	Draws a circle, arc or spiral. (x_0, y_0): coordinates of center (r_0, r_2): initial and final radii (θ_1, θ_2): initial and final angles d: angle or number of segments	
	RELATIVE CIRCLE	] r_1, r_2, θ_1, θ_2 [, d] (t)	Draws a circle, arc or spiral. (r_1, r_2): initial and final radii (θ_1, θ_2): initial and final angles d: angle or number of segments The start point is the current pen position.	
	CURVE	Y a, x_1, y_1, x_2, y_2 .... x_n, y_n (t)	Draws a smooth curve through the points with coordinates (x_1, y_1), (x_2, y_2) .... (x_n, y_n). a = 0: open curve a = 1: closed curve	For specification of (t) see the TERM command.
	RELATIVE CURVE	← a, $\triangle x_1$, $\triangle y_1$, $\triangle x_2$, $\triangle y_2$ .... $\triangle x_n$, $\triangle y_n$ (t)	Draws a smooth curve through points given by successive relative displacements. $(\triangle x_1, \triangle y_1)$: relative coordinates of the start point of the curve from the current pen position $(\triangle x_2, \triangle y_2)$ ... $(\triangle x_n, \triangle y_n)$ relative direct displacements of successive points a = 0: open curve a = 1: closed curve	The "←" character is "_" in the JIS codes.

	ELLIPSE	) a, x_0, y_0, r_1, r_2 θ_1, θ_2, θ_3,	Draws an ellipse. a: the pen moves from its current position to the start point, raised when a = 0 and lowered when a = 1. (x_0, y_0): center of ellipse (r_1, r_2): major and minor radii (θ_1, θ_2): initial and final angle of ellipse θ_3: angle between major axis and X-axis	
Line type specification	LINE TYPE	L p,	Specifies the line type. p = 0: solid line p = 1 - 4: dotted and broken lines p = 5 - 6: dot-dash lines p = 7 - 8: double-dot-dash lines	Initial setting is p = 0
	LINE SCALE	B ℓ	Specifies the pitch for broken lines by ℓ . (Has no effect on solid lines)	Initial setting is ℓ = 100
Character and symbol specifications	FONT	$n, (m,)	Selects type of characters written by PRINT and KANA commands according to the character code charts by parameter n, and the resolution of characters by parameter m.	Initial setting is n = 60, m = 4.
	ALPHA SCALE	S n, (m,)	n specifies the height of characters and symbols and m their width.	Initial setting is n = m = 30
	ALPHA SPACE	Q ℓ, (k,)	n specifies the horizontal spacing from one character or symbol to the next, and k the vertical spacing.	Initial setting is ℓ = 30, k = 0.

	ALPHA ROTATE	R θ,	θ specifies the rotation of characters and symbols.	Initial setting is θ = 0
	ALPHA ITALIC	I p,	p specifies the slope of characters and symbols. p = 256.tanθ (θ is the inclination from the Y-axis)	Initial setting is p = 0
	LABEL POSITION	L P n (t)	Moves the start point of character string writing to the place specified by n.	Initial setting is n = 1.
	ALPHA RESET	A	Returns character and symbol specifications to their initial values.	
Control functions	CLEAR	:	Initializes the plotter, returns all control settings to their initial values.	
	HOME	H	Moves the raised pen to the HOME position.	
	OFFSET	↑ x, y,	Sets the origin to the coordinates (x, y).	Initial setting is the same as the HOME POSITION. " ↑ " is "^" in JIS codes.
	OFFSET POLAR	↑ P x, y [, θ_0 [,f](t)	. Sets the polar origin at (x, y). . Rotates coordinate system by θ, centered on (x, y). . f sets a division angle for the whole circle.	Initial setting is the HOME POSTION, θ_0 = 0, f = 3600
	NEW PEN	J n,	Selects pen n	Initial setting is n = 1
	PROMPT LIGHT	T n,	Controls the PROMPT LAMP on the control panel. n = 0: off n = 1: on	Initial setting is off.

	WRITE LOWER LEFT	\ x, y,	Specifies the coordinates of the lower left corner of the plotting area.	Initial setting is x = y = 0
	WRITE UPPER RIGHT	Z x, y,	Specifies the coordinates of the upper right corner of the plotting area.	Initial setting gives the maximum plotting area.
	ROTATE	/ x, y, θ,	Rotates drawing around (x, y). (x, y): center of rotation θ: angle of rotation	
	CLIPPING	> x_1, y_1, ..., x_n, y_n (t)	Clips part of drawing. x_n, y_n: string of points defining clipping pattern	
	SPEED	! ℓ [,n] (t)	Sets the pen speed when down, in 10 stages. (ℓ = 1, 2, ... 10) n: specified pen number	Initial setting is ℓ = 10
	FACTOR	&, p, q, r,	Sets the plotting magnification. p/r = magnification along X-axis q/r = magnification along Y-axis	Initial setting is p = q = r = 1
Read-out of coordinates	GIN	G	Transmits the current pen x and y coordinates and pen up/down status to the computer.	Data is transmitted in the order: x coordinate, y coordinate, pen status.
	CALL GIN	C	Transmits the current pen position and pen status when the ENTER key on the control panel is pressed.	
	READ OFFSET	?	Transmits the coordinates of the origin to the computer.	

	READ LOWER LEFT	[	Transmits the coordinates of the lower left corner of the plotting area to the computer.	Data is transmitted in the order: x coordinate then y coordinate.
	READ UPPER RIGHT	U	Transmits the coordinates of the upper right corner of the plotting area to the computer.	
Interface control	INTERFACE CLEAR	;	Initializes interface control. Any data remaining in the buffer will be lost.	
	READ STATUS WORD 1	V	Transmits plotter status 1 to the computer. Transmission takes place immediately this command is received.	
	READ STATUS WORD 2	@	Transmits plotter status 2 to the computer.	
	READ STATUS WORD 3	#	Transmits plotter status 3 to the computer. Transmission takes place if the buffer space available is at least 256 bytes when this command is received.	
	TERM	$= t_1, t_2$	Specifies the data terminator characters t_1 and t_2. t_1 and t_2 may be the same.	Initial setting is $t_1 = t_2 =$ (ETX)
	ERROR MASK	" m, n, p,		Initial setting is m = 1 n = 0 p = 0

Graph plotting	AXIS	X p, q, r, [, t_1, t_2] (t)	Draws a coordinate axis parallel to the X- or Y-axis. p = 0 (Y-axis) q = unit length, p = 1 (X-axis) r = number of repeats p = 2 (Y-axis) q = total length, p = 3 (X-axis) r = number of divisions	t_1, t_2 = lengths of scale marks
	HATCHING	% n, x, y, d, θ (t)	Draws a rectangle parallel to the X- and Y-axes, a circle, or straight line segments connecting a string of points, and also hatching. n = 1: rectangle only n = 2: hatching only n = 3: rectangle with internal hatching d: line spacing of hatching θ: angle of hatching from X-axis	
		% n, r_1, r_2, θ_1, θ_2, d, θ (t)	n = 11: fan shape only n = 12: hatching only n = 13: fan with hatching r_1, r_2: radii of circle θ_1, θ_2: start and end of fan drawn d, θ: same as for rectangle	
		% n, d, θ, x_1, y_1, ……… … x_n, y_n (t)	n = 21: string of points n = 22: hatching only n = 23: string of points with internal hatching d, θ: same as for rectangle x_n, y_n: coordinates of points	

10-3 Descriptions of HP-GL emulation commands

10-3-1 RS-232-C interface control commands

Table 10-3-1 Table of interface control commands

No.	Command	Command format	Function
1	ESC. (	ESC. (	Turns plotter on
	ESC. Y	ESC. Y	Turns plotter on
2	ESC.)	ESC.)	Turns plotter off
	ESC. Z	ESC. Z	Turns plotter off
3	ESC. @	ESC. @ <DEC>; <DEC>:	Specification of ER line and buffer size
4	ESC. B	ESC. B	Output of buffer size
5	ESC. E	ESC. E	Output of error status
6	ESC. H	ESC. H <DEC>; <ASC>; ....:	Specification of handshake mode 1
7	ESC. I	ESC. I <DEC>; <ASC>; ....:	Specification of handshake mode 2
8	ESC. J	ESC. J	Interface command inhibition
9	ESC. K	ESC. K	Buffer clear
10	ESC. L	ESC. L	Output of buffer size
11	ESC. M	ESC. M <DEC>; <ASC>; ....:	Specification of output mode
12	ESC. N	ESC. N <DEC>; <ASC>; ....:	Specification of output mode
13	ESC. O	ESC. O	Output of status
14	ESC. R	ESC. R	Handshake command initialization

Note: ESC is the escape character which is 1BH in hexadecimal notation and 27 in decimal notation.

(1) Plotter-on

[ESC. ( ] or [ESC. Y]

These put the plotter on-line.

(2) Plotter-off

[ESC.)] or [ESC. Z]

These put the plotter off-line.
(The plotter is on-line when the power is turned on)

(3) Specification of ER line and buffer size

[ESC. @ <DEC>; <DEC>:]

<DEC> Specification of maximum buffer size (initial setting: 1024 bytes)
Any value from 0 to 1024 bytes can be specified.
Values from 1025 to 9999 are regarded as 1024 bytes.

<DEC> Control of ER (Data terminal ready)
ER is always on when the least significant bit is 0, and is controlled when 1.
When controlled, ER goes on if the space available in the buffer is larger then the current block size, and goes off if not.
(Initial setting: Bit 1 = 0)

(4) Output of buffer space available

[ESC. B]

This outputs the buffer space available.

Responses

<DEC> Decimal value between 6144 to 0, indicates the currently available buffer space.

[TERM] Terminator. If no terminator has been specified by an ESC.M command, CR (Carriage Return) functions as the terminator.

(5) Output of error status

[ESC. E]

This outputs the interface error status.

Response

<DEC> A decimal value between 0 to 16, indicating the following error statuses, is output in response.

Table 10-3-2 Error statuses

Error No.	Meaning
0	No error
10	Output command received while another was being processed
11	Unclear byte received after ESC
12	A byte of interface control command parameters is unclear
13	Parameter overflow
14	Too many parameters received
15	Framing, parity or overrun error
16	Input buffer overflow

(6) Specification of handshake mode 1

[ESC. H <DEC>; <ASC>; <ASC>(; .... <ASC>):]

The parameters are the same as those for ESC. I (Handshake mode 2 specification). However, the usage of the parameters specified by ESC. M or ESC. N differ.

Table 10-3-3 Handshake modes

Parameter	Handshake response or X-on trigger character		Output command response
	Mode 1	Mode 2	
Turnaround delay	O	O	O
Output trigger character	O	X	O
Echo terminator	O	X	O
Output terminator	O	X	O
Intercharacter delay	O	O	O

O Effective
X Not effective

(7) Specification of handshake mode 2

[ESC. I <DEC>; <ASC>; <ASC>(; .... <ASC>):]

<DEC>

- This is the level at which X-off is output in X-on/off handshake mode.
- The X-on output level is:

  Max. buffer size ÷ 2 when X-off is ½ or less of the max. buffer size

X-off output level + 1 when X-off is more than ½ of the max. buffer size

Initial setting is 80 bytes.

o This specifies the data block size in ENQ/ACK handshake mode. Initial setting is 80 bytes.

<ASC> Initial setting: 0 (null)

o Always 0 in X-on/X-off handshake mode.

o This specifies the ENQ character when in ENQ/ACK handshake mode. The character must be within the range of 1 - 127, 0 cannot be specified. 5 is usually used.

<ASC> Any characters between 1 and 10 can be specified.

<ASC> Any value from 0 to 127 can be specified by the characters.

o This specifies the X-on trigger character in X-on/X-off handshake mode.

o This specifies the handshake response character in ENQ/ACK handshake mode. 6 (the ACK character) is usually used.

(8) Interface command inhibition

[ESC. J]

This inhibits the interface handshake control, the plotter stops the data output and waits for an echo character, for example.

(9) Buffer clear

[ESC. K]

This clears all the data within the buffer and stops the plotting.

(10) Output of buffer size

[ESC. L]

The plotter waits until a buffer space equivalent to the max. buffer size specified by an ESC.@ command is available, and then responds with the buffer size.

Responses

<DEC> Buffer size expressed as decimal value

[TERM] Terminator. If not specified, CR (Carriage Return) is used as terminator.

(11) Specification of output mode

[ESC. M<DEC>;<ASC>;<ASC>;<ASC>(;<ASC>):]

This specifies the conditions for data output.

<DEC> Turnaround delay (0 - 9999 msec)
This specifies delay before output starts.
Initial setting is 0.

<ASC> Output trigger character
This specifies the character used to start output.
Initial setting is 0.

<ASC> Echo terminator character
This character specifies the restart of input after output.
Initial setting is 0.

<ASC>
<ASC> These specify the terminators for output data, one or two characters can be specified as terminators. Any values between 1 - 127 can be used, 0 is not valid.
Initial setting is 13; 0 (CR - Carriage Return - only)

(12) Specification of output mode (2)

[ESC. N <DEC>; <ASC> (; .... <ASC>):]

This specifies the conditions for data output.

<DEC> Intercharacter delay (0 - 9999 msec)
This specifies the delay between characters in data output.
Initial setting is 0.

<ASC> Any characters between 1 and 10 can be specified.
<ASC>

- o In X-on/X-off handshake mode, this specifies the X-off trigger character
- o In ENQ/ACK handshake mode, the specifies the initial character response.

(13) Output of status

[ESC.O]

This outputs the plotter status.

<DEC> 0 - Buffer is not empty.
8 - Buffer is empty and ready for data.

[TERM] Terminator. If not specified, CR (Carriage Return) is used as terminator.

(14) Command initialization

[ESC. R]

This returns the parameters for handshake control to their initial values.

10-3-2 Command functions

Table 10-3-4 Table of commands

No.	Command	Command format	Function
1	DF	DF;	Initialization of plotter functions
2	IN	IN;	Initialization of plotter
3	IP	IP P_{1X}, P_{1Y}, P_{2X}, P_{2Y};	Specification of P1, P2
4	OP	OP (;)	Output of P1, P2
5	SC	SC X_{min}, X_{max}, Y_{min}, Y_{max};	Specification of scale
6	SP	SP n;	Selection of pen
7	PU	PU X_1, Y_1 (, ...);	Pen-up movement
	PD	PD X_1, Y_1 (, ...);	Pen-down movement
8	PA	PA X_1, Y_1 (, ...);	Move by absolute displacements
9	PR	PR X_1, Y_1 (, ...);	Move by relative displacements
10	CI	CI r (, φ);	Drawing of circle
11	AA	AA x, y, θ (, φ);	Drawing of arc
12	AR	AR $\triangle$x, $\triangle$y, θ (, φ);	Drawing of arc
13	AP	AP (n);	Specification of automatic pen-up
14	VS	VS v (, n);	Specification of pen speed
15	XT	XT (;)	Drawing of graduated X-axis
	YT	YT (;)	Drawing of graduated Y-axis

16	TL	TL tp (, tm);	Specification of pitch for graduated axes
17	SM	SM c;	Specification of marks
18	LT	LT n, ℓ ;	Selection of line type
19	CS	CS n;	Selection of standard character set
20	CA	CA n;	Selection of auxiliary character set
21	SS	SS (;)	Specification of standard character set
22	SA	SA (;)	Specification of auxiliary character set
23	LB	LB c_1 c_2 .... c_n t	Writing of character string
24	DT	DT t;	Specification of character string terminator
25	DI	DI run, rise;	Specification of character orientation
26	DR	DR run, rise;	Specification of relative character orientation
27	SI	SI width, height;	Specification of character size
28	SR	SR width, height;	Specification of relative character size
29	SL	SL tanθ;	Specification of character slope
30	CP	CP n, m;	Movement of pen by one character
31	UC	UC (c_1) x_1, y_1 (,c) (, ...);	Writing of user-defined characters

32	OA	OA (;)	Output of mechanical coordinates
33	OC	OC (;)	Output of programmed coordinates
34	OE	OE (;)	Output of error number
35	OF	OF (;)	Output of factor
36	OI	OI (;)	Output of plotter model number
37	OO	OO (;)	Output of options
38	OS	OS (;)	Output of status
39	IM	IM e (, s (, p));	Input of masks
40	IW	IW X_{LL}, Y_{LL}, X_{UR}, Y_{UR};	Input of plotting area
41	OW	OW (;)	Output of plotting area
42	DP	DP (;)	Digitization of pen position
43	DC	DC (;)	Digitization clear
44	OD	OD (;)	Output of digitized point
45	LO	LO(n);	Specification of start point of character string
46	XA YA	XA y(,d(,x1(,x2(,n)))); YA x(,d(,y1(,y29,n))));	Drawing of coordinate axes
47	GR	GR d, Y1 (,Y2 ....Yn);	Graph relative

The program resolution initially is 25 μm, this is equivalent to a resolution of 0.1 mm for pen movements, although it can be changed by a SCALE command.

(1) Initialization of plotter functions DF

[DF;]

This initializes the various plotter functions (see Table 10-3-5.)

Table 10-3-5 Table of DF settings

No.	Function	Initial settings
1	Plotting mode	Movements by absolute displacements (PA)
2	Relative character orientation	Horizontal (DR 1, 0)
3	Line type	Solid line
4	Pitch of broken line	4 % of distance between P1 and P2.
5	Plotting area (window)	Max. valid plotting area (IW 0, 0, 16000, 11400)
6	Character size	Width: $(P_{2X} - P_{1X}) \times 0.75$ % Height: $(P_{2Y} - P_{1Y}) \times 1.5$ %
7	Mark specification	None
8	Pitch of graduated axes	Positive = Negative = $(P_{2X} - P_{1X}) \times 0.5$ % .... Y-axis $(P_{2Y} - P_{1Y}) \times 0.5$ % .... X-axis
9	Automatic pen-up	Pen raised automatically
10	Pen speed	Max. speed
11	Selection of character set	Standard character set
12	Standard character set	Set 0
13	Katakana set	Set 0
14	Character slope	0°

15	Masks	223
16	Digitization	Cleared
17	Scale specification	None
18	Character string terminator	ETX
19	P1	(200, 200)
20	P2	(15800, 11200)

(2) Initialization of plotter IN

[IN;]

This initializes the plotter. It:

- o Initializes the plotter's functions (same as with DF command)
- o Initializes P1, P2 (IP 200, 200, 15800, 11400)
- o Moves the pen to the mechanical origin of plotter
- o Clears errors
- o Turns on Bit 3 of STATUS.

(3) Input of P1, P2 IP

$$\left[\begin{array}{l} \text{IP } P_{1X}, P_{1Y}, P_{2X}, P_{2Y}; \\ \text{IP;} \end{array}\right]$$

- o $+32767 \geqq$ all parameters $\geqq -32767$
- o Decimal fractions ignored
- o When $P_{1X}, P_{2X} > 16000$, $P_{1X}, P_{2X} = 16000$
  When $P_{1Y}, P_{2Y} > 11400$, $P_{1Y}, P_{2Y} = 11400$
  When $P_{1X}, P_{1Y}, P_{2X}, P_{2Y} < 0$, $P_{1X}, P_{1Y}, P_{2X}, P_{2Y} = 0$
- o $P_{1X} \neq P_{2X}, P_Y \neq P_{2Y}$

This specifies P1 as (P_{1X}, P_{1Y}), P2 as (P_{2X}, P_{2Y}) and turns on Bit 1 of OUTPUT STATUS.

When a parameter is omitted, the corresponding initial value is automatically specified, (200, 200, 15800, 11400). The pitch of broken lines, that of graduated axes, the relative orientation of characters, and relative character size depend on the values of P1, P2 set by the IP command.

(Example) IP 3000, 2000, 8000, 7000;

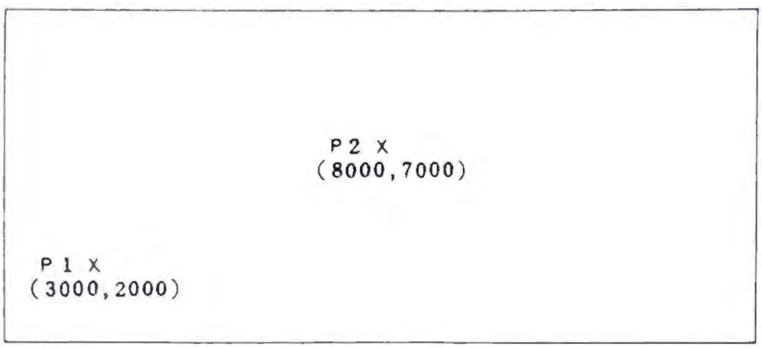


Fig. 10-3-1 Input of P1, P2

(4) Output of P1, P2 OP

[OP (;)]

This outputs the values of P1 and P2 currently specified. Any zeroes in the output data are suppressed so that no spaces are output.

$P_{1X}, P_{1Y}, P_{2X}, P_{2Y}$ CR

Bit 1 of OUTPUT STATUS is turned off.

(Example) 200, 200, 15800, 11200 CR

(5) Specification of scale SC

$$\left[\begin{array}{l} SC\ X_{min},\ X_{max},\ Y_{min},\ Y_{max}; \\ SC; \end{array}\right]$$

- o +32767 ≥ all parameters ≥ -32767
- o Decimal fractions ignored
- o $X_{min} \neq X_{max}$, $Y_{min} \neq Y_{max}$
- o $32767 \geq \left(\dfrac{X_{max} - Y_{min}}{Y_{max} - Y_{min}} \right) \geq -32767$

This specifies the user's own coordinates for P1 (P_{1X}, P_{1Y}), P2 (P_{2X}, P_{2Y}). The relationships between the coordinates of the mechanical origin (X_m, Y_m) and the user's coordinates (X_u, Y_u) are given by the following formulae:

$$X_m = \left(\frac{P_{2X} - P_{1X}}{X_{max} - Y_{min}} \right) * (X_u - X_{min}) + P_{1X}$$

$$Y_m = \left(\frac{P_{2Y} - P_{1Y}}{Y_{max} - Y_{min}} \right) * (Y_u - Y_{min}) + P_{1Y}$$

When parameters are omitted, no scale is specified.

(Examples) IP; SC 0, 10, 0, 10;

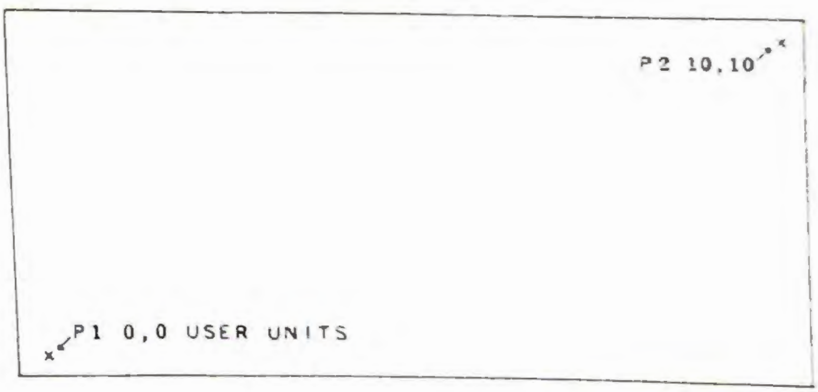


Fig. 10-3-2 Scale specification 1

IP 0, 0, 1000, 1000; SC 0, 10, 0, 10;

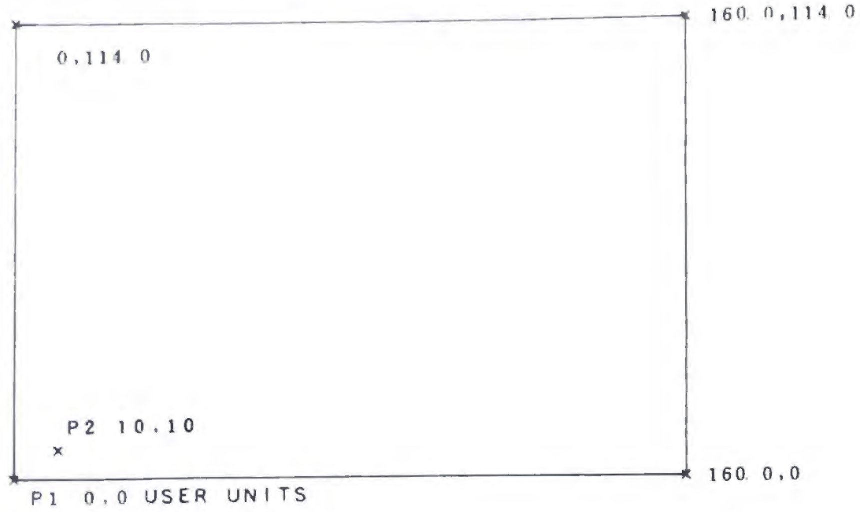


Fig. 10-3-3 Scale specification 2

(6) Selection of pen SP

$$\left[\begin{array}{l} \text{SP n;} \\ \text{SP;} \end{array}\right]$$

o $10 \geq n \geq 0$

This selects the pen specified by n.

When the parameter is omitted or n = 0, the current pen is returned to the stocker.

(7) Pen controls PU PD

$$\left[\begin{array}{l} \text{PU;} \\ \text{PD;} \\ \text{PU } X_1, Y_1 \text{ (, ...);} \\ \text{PD } X_1, Y_1 \text{ (, ...), PA ....} \end{array}\right]$$

This moves the pen raised (PU) or lowered (PD).

Whether the pen is moved by an absolute displacement or a relative displacement depends on the PA, PR command given immediately before this command. Refer to the descriptions of the PA, PR commands for details of the parameters.

When the parameters are omitted, the pen does not move, and the current pen status is stored.

For PD, the specification of an LT command is effective.

(8) Move by absolute displacements PA

$$\begin{bmatrix} \text{PA } X_1, Y_1 \text{ (, } X_2, Y_2, \text{ ....);} \\ \text{PA;} \end{bmatrix}$$

o $+32767.9999 \geq X_i, Y_i \geq -32767.9999$

o Decimal fractions are valid when scale is specified, but are ignored when scale is not specified.

This moves the pen to the absolute coordinates given as parameters. The status of the pen during the move depends on the PU or PD command immediately beforehand.

Whether scale is specified or not is determined by an SC command immediately before this command. PU, PD, PR commands can be combined with this command by punctuating them with commas (,). When the parameters are omitted, the pen does not move and the pen status is stored.

(Example) IN;
PA 2000, 1500, PD, 0, 1500, 2000, 3500, 2000, 1500, PU, 2500, 1500;
PA PD 4500, 1500, 2500, 3500, 2500, 1500;

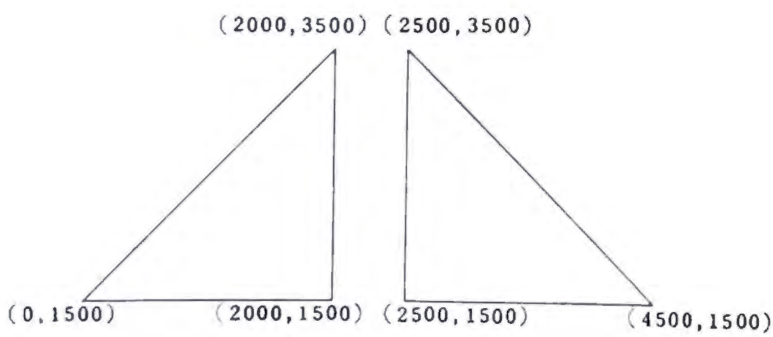


Fig. 10-3-4 Moves by absolute displacements

Note: When a parameter error occurs, the parameters received before the error remain valid, but those received after it are ignored.

(9) Move by relative displacements PR

$$\left[\begin{array}{l} PR\ X_1,\ Y_1\ (,\ X_2,\ Y_2,\ \ldots\ldots\ldots);\\ PR, \end{array}\right]$$

- o $+32767.9999 \geq X_i, Y_i \leq -32767.9999$
- o Decimal fractions are valid when scale is specified, but are ignored when scale is not specified.

This moves the pen through the distance specified by the parameters. The status of the pen during the move depends on the PU or PD command immediately beforehand.

Whether scale is specified or not is determined by an SC command immediately before this command. PU, PD and PA commands can be combined by with this command by punctuating them with commas (,). The coordinates of the point to which the pen is moved by the relative displacements specified by this command cannot exceed +32767.999 or -32767.999.

When the parameters are omitted, the pen does not move and the pen status is stored.

Note: When a parameter error occurs, the parameters received before the error remain valid, but those received after it are ignored.

(Example) IN;
PA 2000, 1500, PD PR -2000, 0, 2000, 2000, 0, -2000;
PU 500, 0, PD 2000, 0, -2000, 2000, 0, -2000, PU;

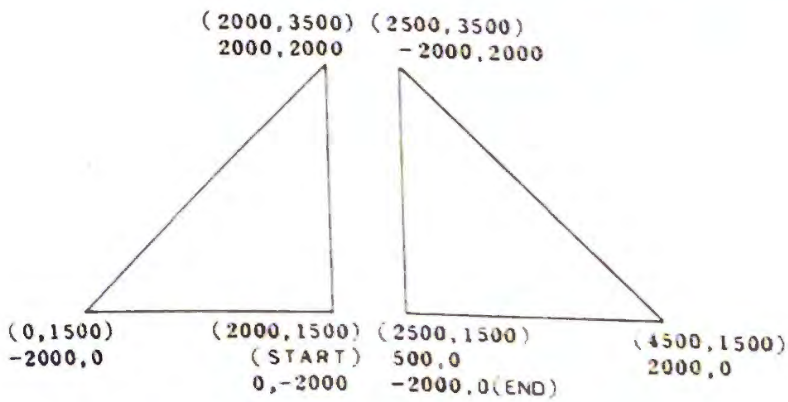


Fig. 10-3-5 Moves by relative displacements

(10) Circle CI

[CI r(, φ);]

o	r (radius)	$+32767.9999 \geq r \geq -32767.9999$	
		Decimal fractions are valid when scale is specified.	
	r: +	Drawing starts at 0°	
	r: -	Drawing starts at 180°	
o	φ : +	Angle of divisions	$+3276.7 \geq \varphi \geq 0.1$
			(Can be specified in steps of 0.1°)
	φ : -	Number of divisions	$0 \geq \varphi \geq -32767$

This draws a circle with a radius of r, centered on the current pen position. The start point of the circle is determined by whether r is positive or negative. The pen returns to the center when the circle is completed.

The circle is drawn regardless of any PU or PD command. When φ is omitted or $\varphi = 0$, the angle of divisions is set to 5°.

The specifications by SC and LT commands are effective.

(Examples) CI 1000; CI -1000;

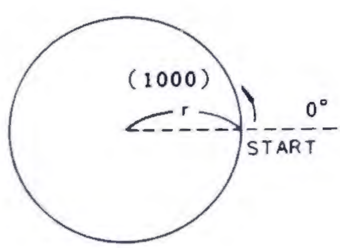


Fig. 10-3-6 Circle 1

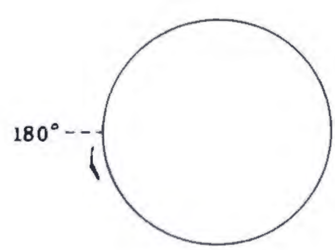


Fig. 10-3-7 Circle 2

CI 1000, 60;
CI 1000, -6;

CI 1000, 30;
CI 1000, -12;

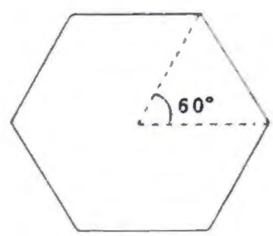


Fig. 10-3-8 Circle 3

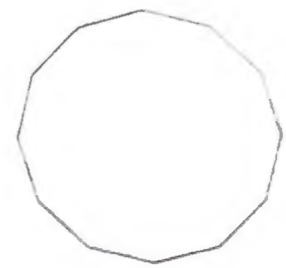


Fig. 10-3-9 Circle 4

IP 0, 0, 10000, 10000; SC 0, 5000, 0, 10000;
CI 1000;

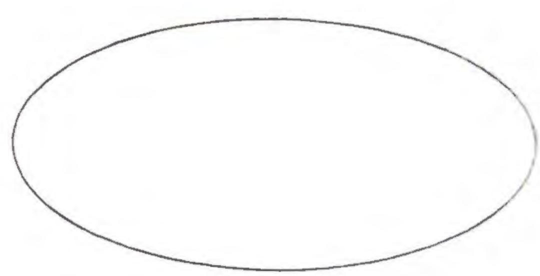


Fig. 10-3-10 Circle 5

(11) Arc (absolute coordinates) AA

[AA x, y, θ (, φ);]

o	x, y	$+32767.9999 \geqq x, y \geqq -32767.9999$ When scale is specified, decimal fractions are valid.
o	θ (plot angle)	$+3276.7 \geqq \theta \geqq -3276.7$
	+:	measured counterclockwise
	-:	measured clockwise
o	φ	Same as in CI.

This draws an arc through an angle of θ° centered on the point (x, y), starting from the pen's current position.

If no PD command has been given immediately beforehand, the pen moves raised so that the arc is not actually drawn.

When φ is omitted or φ = 0, the angle of divisions is set to 5°.

Specifications by SC and LT commands are effective.

(Examples) AA 1000, 1000, 60; AA 1000, 1000, -60;

Fig. 10-3-11 Arc 1

Fig. 10-3-12 Arc 2

AA 1000, 1000, 180, 60;
AA 1000, 1000, 180, -3;

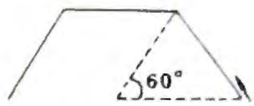


Fig. 10-3-13 Arc 3

(12) Arc (relative coordinates) AR

[AR $\triangle$x, $\triangle$y, θ (, φ);]

o	$\triangle$x, $\triangle$y	$+32767.9999 \geqq \triangle x, \triangle y \geqq -32767.9999$ When scale is specified, decimal fractions are valid.
o	θ	Same as in AA.
o	φ	Same as in AA.

This draws an arc through an angle of θ° centered on a point ($\triangle$x, $\triangle$y) away from the current pen position.

The other details are the same as those of the AA command.

(Example) AR -1000, -1000, -60;

Fig. 10-3-14 Arc 4

(13) Automatic pen-up AP

[AP (n);]

This raises the pen automatically whenever the pen has not moved for 5 seconds.

When the parameter is omitted, the automatic pen-up function is specified. When the parameter is given, this function is not activated. The actual value of the parameter has no particular meaning.

(14) Specification of pen speed VS

[VS v (, n);]

o v (speed) $15 \geqq v \geqq 0$ (decimal fractions ignored)
n (pen number) $6 \geqq n \geqq 1$

This specifies the speed (in cm/s) of the selected pen. When the pen number is omitted, the specified pen speed applies to all pens.

When the pen speed parameter (v) is omitted as well, all the pens will move at the initial setting speed. The same applies when the speed parameter (v) is 0.

Specified speed	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Actual measurement(cm s)	1.5	1.5	1.5	3	4.5	4.5	6	7.5	7.5	9	10.5	10.5	12	13.5	13.5	15

Table 10-3-6 Pen speeds

(15) Graduated axes XT YT

$$\left[\begin{array}{l} \text{XT (;)} \\ \text{YT (;)} \end{array}\right]$$

XT draws straight line segments perpendicular to the X-axis, YT draws them perpendicular to the Y-axis. The pitch of the segments is specified by a TL command.

This command is not affected by PD, PU, LT and SC commands.

(Example) IN; PA 1000, 4000, PD; XT; PR 4000, 0; XT; PR 4000, 0; XT;

Fig. 10-3-15 Graduated axis

(16) Specification of graduation pitch TL

[TL tp (, tm);]

o $+127.9999 \geq$ tp, tm ≥ -127.9999

This specifies the pitch of graduated axes.

tp: pitch in the positive XT and YT directions
pitch in the positive XT direction = $(P_{2Y} - P_{1Y}) \times$ tp %
pitch in the positive YT direction = $(P_{2X} - P_{1X}) \times$ tp %

tm: pitch in the negative XT and YT direction
pitch in the negative XT direction = $(P_{2Y} - P_{1Y}) \times$ tm %
pitch in the negative YT direction = $(P_{2X} - P_{1X}) \times$ tm %

When tm is omitted, tm = 0.

When both parameters (including tp) are omitted, they are automatically set to their initial settings (tp = tm = 0.5)

(Example)

```
  10  IN; PU; PA 200, 200; PD; TL 100; XT;
* 20  FOR I = 1 to 10
  30  PR 1484, 0; XT;
* 40  NEXT I
  50  PU; PA 200, 200; PD; YT;
* 60  FOR J = 1 to 10
  70  PR 0, 976; YT;
* 80  NEXT J
  90  PU;
```

- o * are BASIC commands.
- o Data within the boxes is for the plotter.

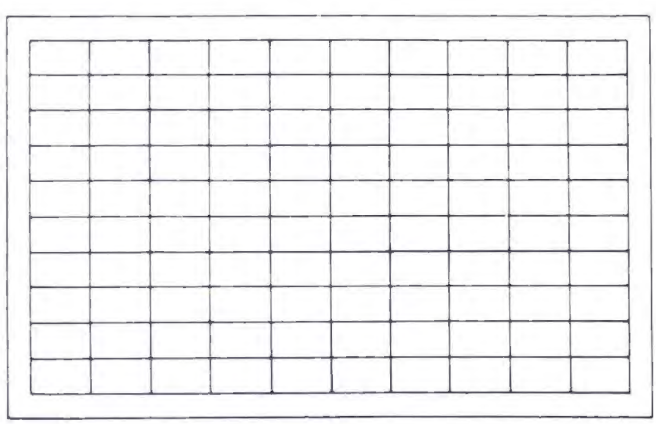


Fig. 10-3-16 Specification of pitch of graduated axes

(17) Specification of marks SM

[SM c;]

o c: Single character, any print character other than ";".

This draws the specified character at the end of a line segment specified by a PA, PR, PU or PD command.

The character is drawn even when a command to raise the pen has been given. The character drawn is affected by SI, SR, DI and DR commands.

When the parameter is omitted, or when c is less than 21H, the SM mode is cancelled, and nothing is drawn at the end of the line segment.

(Example) IN, PU; PA 1000, 1000; SM *; PD PA 1000, 3000, PA 6000, 5000; PA 1000, 1000, PU;

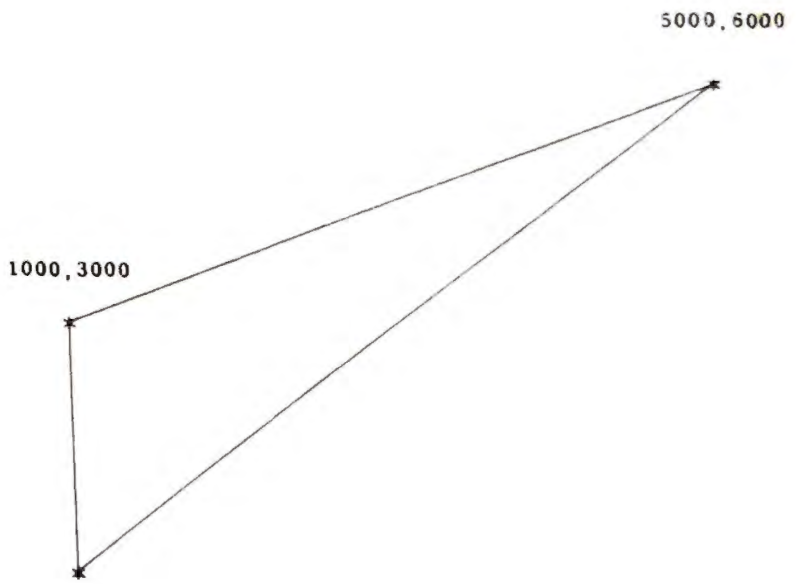


Fig. 10-3-17 Specification of marks

(18) Selection of line type LT

[LT n, ;]

- Line type $6 \geqq n \geqq 0 \rightarrow$ broken line

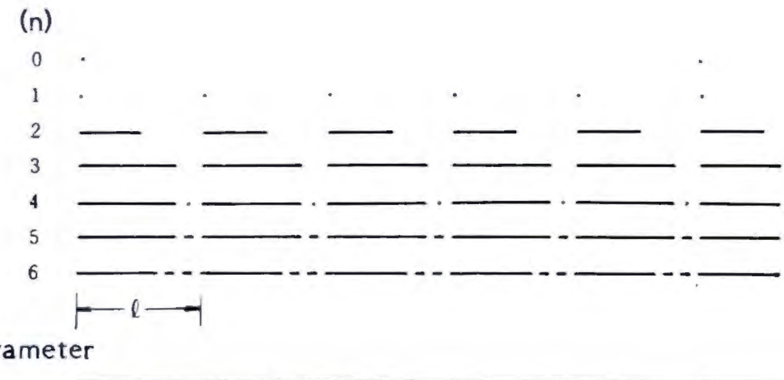
  $0 > n \geqq -127 \rightarrow$ solid line
- Pitch $127.9999 \geqq \ell > 0$

This specifies the type of line and the pitch of broken lines. The line types are as shown below. When the parameters are omitted, solid lines are drawn.

The pitch of broken lines is specified as a percentage of the distance between P1 and P2. When the parameter is not given, it is set at 4 %.

The LT command affects PA, PR, PD, CI, AA, and AR commands.

(Dots at start and end of line segment)



No parameter

Fig. 10-3-18 Selection of line type

(19) Selection of standard character set CS

[CS n;]

o 8, 4 ≧ n ≧ 0

This selects one of the following character sets 0 - 4 or 8 as the standard character set.

When the parameter is omitted, Set 0 is selected.

Set 0 .... Standard ASCII
Set 1 .... Hp 9825 Set
Set 2 .... French/German
Set 3 .... Scandinavian
Set 4 .... Spanish/Latin American
Set 8 .... Katakana

Some characters in each set, except for the katakana set, are changed to special FONT characters.

An auxiliary character set can be selected to enable switching between the two selected characters sets by SS and SA commands.

The auxiliary character set can also be specified by the shift-out character, and the standard character set by the shift-in character.

(Example) CS 1; CA 8; LB AB S_0 アイウ S_1 CD E_X

ABアイウCD

Fig. 10-3-19 Standard characters

(20) Selection of auxiliary character set CA

[CA n;]

o 8, 4 ≥ n ≥ 0

This selects one of the character sets 0 - 4 or 8 as an auxiliary set. When no parameter is given, Set 0 is selected as the auxiliary set.

Decimal	Set 0 Standard ASCII	Set 1 9825 set	Set 2 French/ German	Set 3 Scandi- navian	Set 4 Spanish/Latin American
35	#	#	£	£	¿
39	'	'	´	'	´
91	[	[	[	Ø	[
92	\	√	ç	Æ	¡
93	]	]	]	ø	]
94	^	↑	^	æ	^
95	_	_	_	_	_
96	`	`	`	`	`
123	{	π	¨	¨	~
124	|	⊢	▾	▾	~
125	}	→	¨	¨	~
126	~	~	'	·	~

Table 10-3-7 Table of standard character sets

The characters within the boxes are written after back-spacing.

(21) Specification of standard character set SS

[SS (;)]

This specifies the use of the standard character set. The character set selected by the CS command is used.

Character sets can be also selected by the following characters, as well as by commands.

To specify standard character set .... Shift-in (decimal 15)
To specify auxiliary character set ..... Shift-out (decimal 14)

(22) Specification of auxiliary character set SA

[SA (;)]

This specifies the use of the auxiliary character set. The character set selected by the CA command is used.

(23) Writing of character string LB

[LB c_1 c_2 ..... c_n t]

- o c_n: 01H - 7FH (for 01H to 20H, nothing is written)
- o t: Terminator specified by DT command

This writes the character string specified by c_1 ..... c_n. All the characters given as far as the terminator specified by a DT command are considered to be part of a single string and are written as a string. When the terminator is a print character, it will also be written at the end of the string.

This command is affected by SI, SR, DI, and DR commands.

The character string is written regardless of any PU or PD command.

(Example) IN; PA 5000, 3000;

LB I AM A PLOTTER E_{T_X}

I AM A PLOTTER

Fig. 10-3-20 Writing of character string

(24) Specification of character string terminator DT

[DT t;]

o t: 01H - 7FH (between 01H to 20H, nothing is written)

The character specified by t is the terminator for LB commands.

If the command is given as "DT;", ";" will be used as the terminator.

The initial setting is ETX (03H).

(25) Specification of character string orientation DI

[DI run, rise;]

o $+127.9999 \geqq \frac{\text{run}}{\text{rise}} \geqq -127.9999$

$\text{run} = \text{rise} \neq 0$

This specifies the orientation of characters and character strings.

The omission of rise has the same effect as rise = 0.

This command is "DI;" when no parameters are given, and "DI 1, 0;" for the initial setting.

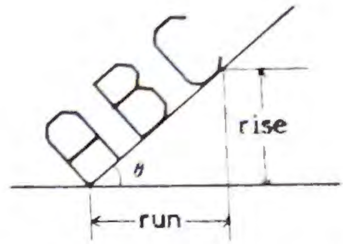


Fig. 10-3-21 Orientation of character string 1

(Example)

IN; PA 5000, 3000;
DI 0, 1; LB 1234 E_X
DI 1, 1; LB 1234 E_X
DI 1, 0; LB 1234 E_X
DI 1, -1; LB 1234 E_X
DI 0, -1; LB 1234 E_X
DI -1, -1; LB 1234 E_X
DI -1, 0; LB 1234 E_X
DI -1, 1; LB 1234 E_X

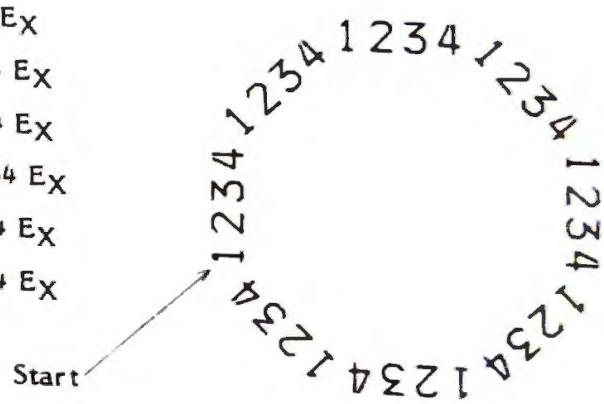


Fig. 10-3-22 Orientation of character string 2

(26) Specification of relative orientation of character (string) DR

[DR run, rise;]

o $+127.9999 \geqq \frac{\text{run}}{\text{rise}} \geqq -127.9999$

run = rise $\neq$ 0

This specifies the orientation of characters and characters strings.

run: specified as percentage of (P_{2X} - P_{1X})

rise: specified as percentage of $(P_{2Y} - P_{1Y})$

Other details are the same as those of the DI command.

(27) Specification of character size SI

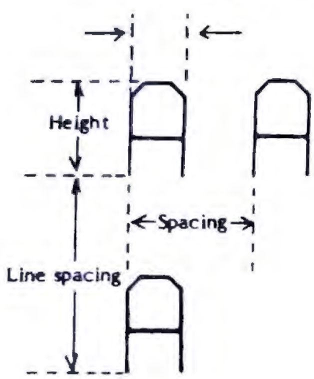
[SI width, height;]

o $+127.9999 \geqq \frac{\text{width}}{\text{height}} \geqq -127.9999\ (\neq 0)$

This specifies the size of characters in centimeters.

When no parameters are given, characters of the following size are drawn:

width: 0.278 cm
height: 0.366 cm



Spacing = Width x 3/2

Line spacing = Height x 2

Fig. 10-3-23 Specification of character size

(Example) IN; PA 200, 5000;
LB 1234 E_X
PA 200, 4000; SI 1.5, 2.5;
LB 1234 E_X

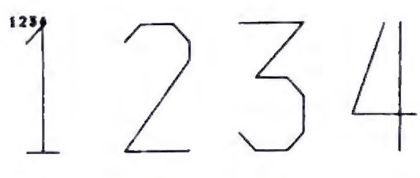


Fig. 10-3-24 Example of character size specification

(28) Specification of relative character size SR

[SR width, height;]

o $+127.9999 \geqq \begin{matrix} \text{width} \\ \text{height} \end{matrix} \geqq -127.9999 \; (\neq 0)$

This specifies the size of characters as percentages related to P1 and P2.

width: percentage of $(P_{2X} - P_{1X})$
height: percentage of $(P_{2Y} - P_{1Y})$

When the parameters are omitted:

width = 0.75 %
height = 1.5 %

The other details are the same as those of the SI command.

(29) Specification of character slope SL

[SL tanθ;]

o +127.9999 ≧ tanθ ≧ -127.9999

This specifies the slope of characters.

When the parameter is omitted, tanθ = 0.

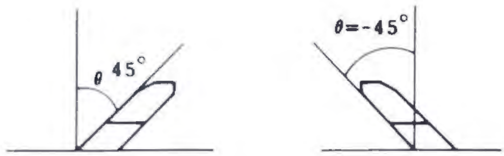


Fig. 10-3-25 Specifications of character slope

(Example) IN; PA 5000, 3000; SL 1; LB 1234 E_X

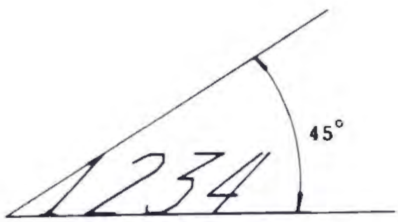


Fig. 10-3-26 Example of the specification of character slope

(30) Pen movement by character spacing CP

[CP n, m;]

o $+127.9999 \geq \begin{matrix} n \\ m \end{matrix} \geq -127.9999$

n: horizontal displacement

units:character spacing (width x 3/2)

m: vertical displacement

units:line spacing (height x 2)

The pen is moved by the character spacings specified by n and m. SI, SR, DI and DR commands affect this command.

This command only moves the pen, no drawing is done even if the pen is down.

When the parameters are omitted (CP;), a carriage return (CR) and line feed (LF) are executed. When the command directly before this is an LB command, the pen (carriage) returns to the start point of the drawing activated by the LB command and a line feed (LF) is executed.

If the pen-movement command directly before this is not an LB or CP command, the line feed is activated from the current pen position.

(31) User-defined characters UC

$[$ UC (c_1) x_1, y_1 (,c)(, ...); $]$

o c: Pen control $+32767.9999 \geq c \geq 99.0000$ - pen down
$-99.0000 \geq c \geq -32767.9999$ - pen up

o x_n, y_n: Displacements expressed as multiples of character grid units.

$$+99.9999 \geq \begin{matrix} x_n \\ y_n \end{matrix} \geq -99.9999$$

1 grid = 1/6 character spacing (x_i)
= 1/16 line spacing (y_i)

This moves the pen from its current position so that it draws the user-defined character by movements specified by the parameters.

The pen control commands within the UC command are only effective for this command and have no effect on others. The up/down status of the pen immediately before this command has no effect on this command, but is maintained after it.

The pen position after the execution of this command is the origin point for the next character.

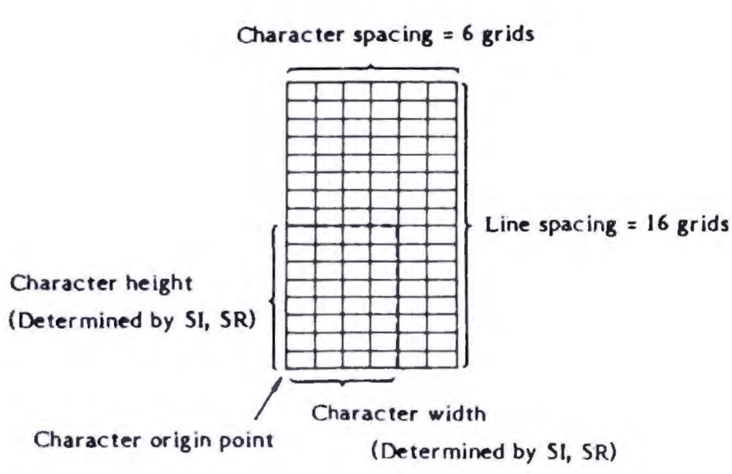


Fig. 10-3-27 User-defined character

(Example) IN; SI 1, 1.5; PU 4000, 8000;

UC -99, 8, 14, 99, 0, 2, -8, 0, 4, -8, -4, -8, 8, 0, 0, 2;

CP: LBEE E_X CP;

UC -99, 4, 7, 99, 0, 1, -4, 0, 2, -4, -2, -4, 4, 0, 0, 1;

Fig. 10-3-28 Example of user-defined characters

(32) Output of mechanical coordinates OA

[OA (;)]

This outputs the X, Y coordinates of the current pen position (units: 25 m) and the pen status.

```
X , Y , P (CR)
 ‾‾‾‾   |
  |     |______ Pen status 0:   pen up
  |                        1:   pen down
  |
  |____________ Coordinates     (Integers)
```

(33) Output of programmed coordinates OC

[OC (;)]

This outputs the X, Y coordinates instructed by the pen-movement command given immediately beforehand, and the pen status.

When scale has been specified, the user's coordinates are converted into integers and output.

When scale has not been specified, the outputs of OA and OC will differ only when the pen goes off-scale. The actual pen position is output with OA, and the coordinates instructed by the command are output with OC.

X , Y , P (CR)

Pen status 0: pen up

1: pen down

Coordinates (Integers)

(34) Output of error number OE

[OE (;)]

This outputs a number indicating what error has occurred immediately beforehand. Bit 5 of OUTPUT STATUS is turned off.

n (CR)

Error number 0 - 8

Error number

0	No error
1	Undefined command detected
2	Numbers of parameters do not match
3	Parameter error (out of range)
4	Not used
5	Not used
6	Coordinate value overflow
7	Not used
8	Paper end (when paper feed mechanism provided)

(35) Output of factor OF

[OF (;)]

This outputs the number of steps per millimeter.

x , y (CR)

Always 40, 40

(36) Output of model number OI

[OI (;)]

This outputs the plotter's model number.

```
××××× (CR)
└── 5301␣
```

(37) Output of options OO

[OO (;)]

This outputs the options available.

```
2 , 1 , 0 , 0 , 1 , 0 , 0 , 0 (CR)
    ↑           ↑
    │           └──── With circle
    │
    └──── Pens selectable
```

(38) Output of status OS

[OS (;)]

This outputs the plotter status expressed as a decimal value.

```
n  (CR)
└──── Integer (0 - 255) indicating status.
```

Table 10-3-8 Plotter status

Bit No.	Decimal	Meaning
0	1	Pen down
1	2	P1 or P2 has been changed, clear by OP command
2	4	Digitized point has been input, clear by OD command
3	8	Plotter initialized, clear by OS command
4	16	Data input enabled
5	32	Error has been generated, clear by OE command
6	64	0
7	128	0

(39) Input of masks IM

[IM e (, s (, p));]

- o e: E-MASK 0 - 255 (Decimal fractions ignored)
- o s: S-MASK 0 - 255 (Decimal fractions ignored)
- o p: P-MASK 0 - 255 (Decimal fractions ignored)

This specifies E-MASK, S-MASK and P-MASK.

If the parameters are omitted, E-MASK is specified as 223. S-MASK and P-MASK are ignored when an RS-232-C interface is used.

When a GP-IB interface is used, however, S-MASK will mask the cause of serial polling and P-MASK the cause of parallel polling.

The values of each of e, s and p are sums of the values of each of the effective bits in the table below.

Error No.	Bit No.	Bit value	Meaning
1	0	1	Undefined command detected
2	1	2	Numbers of parameters do not match
3	2	4	Parameter error
4	3	8	Not used
5	4	16	Not used
6	5	32	Coordinate value overflow
7	6	64	Not used
8	7	128	Paper end

(40) Input of plotting area IW

$$\mathrm{IW}\ X_{LL},\ Y_{LL},\ X_{UR},\ Y_{UR};$$

o $$16000 \geqq \begin{matrix} X_{LL} \\ X_{UR} \end{matrix} \geqq 0 \qquad 32767 \geqq \begin{matrix} X_{LL} \\ X_{UR} \end{matrix} > 16000 \rightarrow \begin{matrix} X_{LL} \\ X_{UR} \end{matrix} = 16000$$

(Decimal fractions ignored)

$$0 > \begin{matrix} X_{LL} \\ X_{UR} \end{matrix} \geqq -32767 \rightarrow \begin{matrix} X_{LL} \\ X_{UR} \end{matrix} = 0$$

o $$11400 \geqq \begin{matrix} Y_{LL} \\ Y_{UR} \end{matrix} \geqq 0 \qquad 32767 \geqq \begin{matrix} Y_{LL} \\ Y_{UR} \end{matrix} > 11400 \rightarrow \begin{matrix} Y_{LL} \\ Y_{UR} \end{matrix} = 11400$$

$$0 > \begin{matrix} Y_{LL} \\ Y_{UR} \end{matrix} \geqq -32767 \rightarrow \begin{matrix} Y_{LL} \\ Y_{UR} \end{matrix} = 0$$

This specifies the valid plotting area.

When the parameters are omitted, the initial settings (IW 0, 0, 16000, 11400) will be used.

When $P_{2X} < P_{1X}$ or $P_{2Y} < P_{1Y}$, the area is not specified.

(41) Output of plotting area OW

[OW (;)]

This outputs the valid plotting area (units: 25 μ m)

X_{LL}, Y_{LL}, X_{UR}, Y_{UR} (CR)

(42) Digitization DP

[DP (;)]

This flashes the PROMPT lamp and the plotter waits for the ENTER button to be pressed. When the ENTER button is pressed:

1. The current pen position and status are stored,
2. The PROMPT lamp stops flashing,
3. Bit 2 of OUTPUT STATUS is turned on.

(43) Digitization clear DC

[DC (;)]

This stops the PROMPT lamp flashing and the plotter waits for the ENTER button to be pressed.

(44) Output of digitized point OD

[OD (;)]

This turns off the flashing PROMPT lamp, turns Bit 2 of OUTPUT STATUS off, and outputs the pen position and status stored by a DP command.

X , Y , P (CR)

Pen status when ENTER button pressed

0: pen up

1: pen down

Coordinates of pen position when ENTER button pressed.

o Inspection certificate

(45) Specification of start point of character string LO

[LO (n);]

This specifies the moving of the start point of the drawing of a character string to a point specified by n.

o $1 \leq n \leq 9$

o When the numerals are other than 1 9, n = 1.

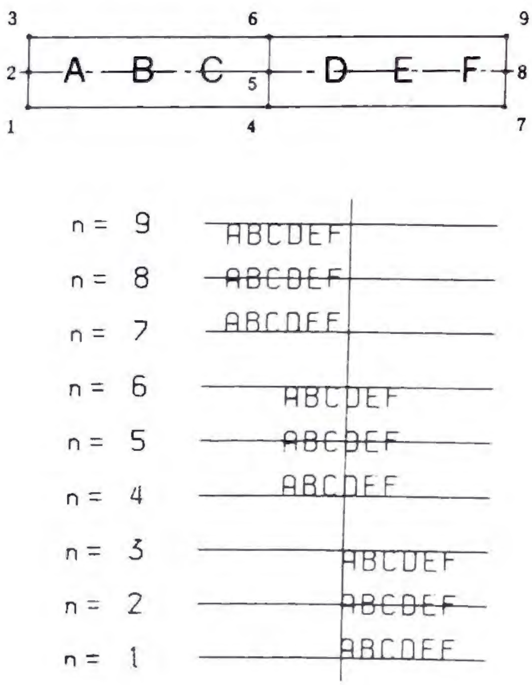


Fig. 10-3-29 Example of LO

(46) Drawing of coordinate axes

[XA   y(,d(,x1(,x2(,n))));]
[YA   x(,d(,y1(,y2(,n))));]

o	x	(X offset)
o	y	(Y offset)
o	d	(tick intervals)
o	x1, y1	(start points)
o	x2, y2	(end points)
o	n	(number of minor tick intervals per major tick)

The Y offset parameter specifies the Y coordinate, in user units, at which the X axis crosses the Y axis.

The X offset parameter specifies the X coordinate, in user units, at which the Y axis crosses the X axis.

The X axis command XA and the Y axis command YA provide the means to draw X and Y axes with specified X and Y offset, tick intervals, start and stop points, and minor and major ticks.

(47) Graph Relative GR

[GR d, Y1 (,Y2.....Yn)]

o   d (increase in the X direction)

o   Yi(Y coordinate value)

As X increases according to the value set by d, when Y is input as a numerical formula, a graph can easily be plotted.

```
10    SC 0,280,0,280
20    AX 50,10,150,5 ; YA 100,10,25,150,5 ;
30    PUPA 7070,0 ;
40    GR 1, PU
*50   FOR  I = - 30  TO = 30
60    Y= I ∧ 2 * 0.1 + 50
70    Y ,  "PD"
*80   NEXT I
```

* Basic commands

☐ Plotting data

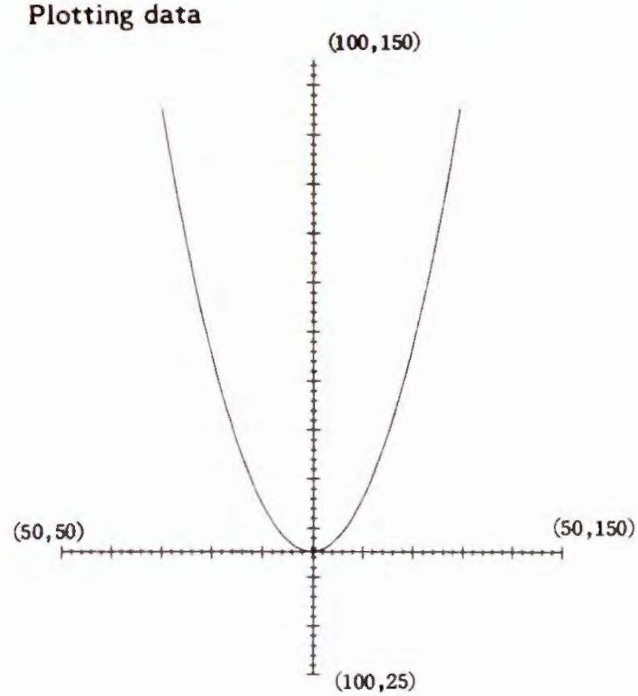


Fig. 10-3-30 Example of graph using XA;YA, GR

11. CHARACTER CODE CHARTS (when using Graphtec commands)

11-1 Alphanumeric and kana code charts

Code chart 1 FONT $ 0, (Standard)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	`	p		SP	SP	ｰ	ﾀ	ﾐ	SP	π
0	0	0	1	1		·	!	1	A	Q	a	q		Γ	｡	ｱ	ﾁ	ﾑ	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	｢	ｲ	ﾂ	ﾒ	β	σ
0	0	1	1	3	ETX	□	#	3	C	S	c	s	ETX	Z	｣	ｳ	ﾃ	ﾓ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Θ	､	ｴ	ﾄ	ﾔ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	･	ｵ	ﾅ	ﾕ	ε	φ
0	1	1	0	6		⧖	&	6	F	V	f	v		Ξ	ｦ	ｶ	ﾆ	ﾖ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		( )	ｧ	ｷ	ﾇ	ﾗ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ｨ	ｸ	ﾈ	ﾘ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ｩ	ｹ	ﾉ	ﾙ	ι	≦
1	0	1	0	A	LF	♤	*		J	Z	j	z	LF	Υ	ｪ	ｺ	ﾊ	ﾚ	κ	≧
1	0	1	1	B		⧗	+	;	K	[	k	{		Φ	ｫ	ｻ	ﾋ	ﾛ	λ	±
1	1	0	0	C		Ƶ	,	<	L	\	l			Ψ	ｬ	ｼ	ﾌ	ﾜ	μ	£
1	1	0	1	D	CR	⌑	-	=	M	]	m	}	CR	Ω	ｭ	ｽ	ﾍ	ﾝ	ν	℃
1	1	1	0	E	SO	✳	.	>	N	↑	n	~	SO	SP	ｮ	ｾ	ﾎ	ﾞ	ξ	∞
1	1	1	1	F	SI	✿	/	?	O	←	o		SI	SP	ｯ	ｿ	ﾏ	ﾟ	ο	

Note: . SP is space code.

. Don't use undefined codes.

The code charts of FONT $ 11, 12 ...... 19 are not given in this appendix. However, they are the same as the code charts of the "B_8 = 0" part of FONTS $ 1 - 9 combined with the "B_8 = 1" part of FONT $ 10.

Code chart 2 FONT $ 1, (ISO)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	`	p		SP	SP	ｰ	ﾀ	ﾐ	SP	π
0	0	0	1	1		·	!	1	A	Q	a	q		Γ	｡	ｱ	ﾁ	ﾑ	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	｢	ｲ	ﾂ	ﾒ	β	σ
0	0	1	1	3	ETX	□	#	3	C	S	c	s	ETX	Z	｣	ｳ	ﾃ	ﾓ	γ	τ
0	1	0	0	4		△	¤	4	D	T	d	t		Θ	､	ｴ	ﾄ	ﾔ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	･	ｵ	ﾅ	ﾕ	ε	φ
0	1	1	0	6		⧖	&	6	F	V	f	v		Ξ	ｦ	ｶ	ﾆ	ﾖ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		( )	ｧ	ｷ	ﾇ	ﾗ	η	ψ
1	0	0	0	8	BS	⊤	(	8	H	X	h	x	BS	Π	ｨ	ｸ	ﾈ	ﾘ	θ	ω
1	0	0	1	9		↘	)	9	I	Y	i	y		Σ	ｩ	ｹ	ﾉ	ﾙ		≦
1	0	1	0	A	LF	♤	*		J	Z	j	z	LF	Υ	ｪ	ｺ	ﾊ	ﾚ	κ	≧
1	0	1	1	B		⧗	+	,	K		k	{		Φ	ｫ	ｻ	ﾋ	ﾛ	λ	±
1	1	0	0	C		Ƶ	,		L	\	l			Ψ	ｬ	ｼ	ﾌ	ﾜ	μ	¢
1	1	0	1	D	CR	⌑	-	=	M		m	}	CR	Ω	ｭ	ｽ	ﾍ	ﾝ	ν	℃
1	1	1	0	E	SO	✳	.	>	N	^	n	‾	SO	SP	ｮ	ｾ	ﾎ	ﾞ	ξ	∞
1	1	1	1	F	SI	✿	/	?	O	_	o		SI	SP	ｯ	ｿ	ﾏ	ﾟ	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 3 FONT $ 2, (Japan)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					SI								SO							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	'	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	□	#	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Θ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ξ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		O	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	个	*	:	J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		X̄	+	;	K	[	k	{		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		Z̄	,	<	L	¥	l	|		Ψ	ャ	シ	フ	ワ	μ	¢
1	1	0	1	D	CR	¤	-	=	M	]	m	}	CR	Ω	ュ	ス	ヘ	ン	ν	℃
1	1	1	0	E	SO	✳	.	>	N	^	n	‾	SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	_	o		SI	SP	ッ	ソ	マ	゜	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 4 FONT $ 3, (U. S. A.)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					SI								SO							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	'	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	□	#	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Θ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ξ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		O	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	个	*	:	J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		X̄	+	;	K	[	k	{		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		Z̄	,	<	L	\	l	¦		Ψ	ャ	シ	フ	ワ	μ	¢
1	1	0	1	D	CR	¤	-	=	M	]	m	}	CR	Ω	ュ	ス	ヘ	ン	ν	℃
1	1	1	0	E	SO	✳	.	>	N	^	n	~	SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	_	o		SI	SP	ッ	ソ	マ	゜	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 5 FONT $ 4, (Britain)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					SI								SO							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	`	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	⊡	£	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Θ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		◷	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ξ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		O	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	⌖	*	:	J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		⧖	+	;	K	[	k	{		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		Z̄	,	<	L	\	l	|		Ψ	ャ	シ	フ	ワ	μ	¢
1	1	0	1	D	CR	⌑	-	=	M	]	m	}	CR	Ω	ュ	ス	ヘ	ン	ν	℃
1	1	1	0	E	SO	✳	.	>	N	↑	n	—	SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	_	o		SI	SP	ッ	ソ	マ	゜	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 6 FONT $ 5, (West Germany)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					SI								SO							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	§	P	`	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	⊡	£	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Θ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		◷	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ξ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		×	'	7	G	W	g	w		O	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	⌖	*	:	J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		⧖	+	;	K	Ä	k	ä		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		Z̄	,	<	L	Ö	l	ö		Ψ	ャ	シ	フ	ワ	μ	¢
1	1	0	1	D	CR	⌑	-	=	M	Ü	m	ü	CR	Ω	ュ	ス	ヘ	ン	ν	℃
1	1	1	0	E	SO	✳	.	>	N	\	n	ß	SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	—	o		SI	SP	ッ	ソ	マ	゜	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 7 FONT $ 6, (France)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	à	P	`	p		SP	SP	ｰ	ﾀ	ﾐ	SP	π
0	0	0	1	1		·	!	1	A	Q	a	q		Γ	｡	ｱ	ﾁ	ﾑ	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	｢	ｲ	ﾂ	ﾒ	β	σ
0	0	1	1	3	ETX	□	£	3	C	S	c	s	ETX	Z	｣	ｳ	ﾃ	ﾓ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		(H)	､	ｴ	ﾄ	ﾔ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	･	ｵ	ﾅ	ﾕ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		H	ｦ	ｶ	ﾆ	ﾖ	ζ	χ
0	1	1	1	7		╳	'	7	G	W	g	w		()	ｧ	ｷ	ﾇ	ﾗ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ｨ	ｸ	ﾈ	ﾘ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ｩ	ｹ	ﾉ	ﾙ	ι	≦
1	0	1	0	A	LF	♤	*	:	J	Z	j	z	LF	Υ	ｪ	ｺ	ﾊ	ﾚ	κ	≧
1	0	1	1	B		⊼	+	;	K	°	k	é		Φ	ｫ	ｻ	ﾋ	ﾛ	λ	±
1	1	0	0	C		Σ	,	<	L	ç	l	ù		Ψ	ｬ	ｼ	ﾌ	ﾜ	μ	℃
1	1	0	1	D	CR	⌑	-	=	M	§	m	è	CR	Ω	ｭ	ｽ	ﾍ	ﾝ	ν	Ꞇ
1	1	1	0	E	SO	✱	.	>	N	^	n	¨	SO	SP	ｮ	ｾ	ﾎ	ﾞ	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	_	o		SI	SP	ｯ	ｿ	ﾏ	ﾟ	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 8 FONT $ 7, (Sweden)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	`	p		SP	SP	ｰ	ﾀ	ﾐ	SP	π
0	0	0	1	1		·	!	1	A	Q	a	q		Γ	｡	ｱ	ﾁ	ﾑ	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	｢	ｲ	ﾂ	ﾒ	β	σ
0	0	1	1	3	ETX	□	£	3	C	S	c	s	ETX	Z	｣	ｳ	ﾃ	ﾓ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		(H)	､	ｴ	ﾄ	ﾔ	δ	υ
0	1	0	1	5		○	%	5	E	U	e	u		Λ	･	ｵ	ﾅ	ﾕ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		H	ｦ	ｶ	ﾆ	ﾖ	ζ	χ
0	1	1	1	7		╳	'	7	G	W	g	w		()	ｧ	ｷ	ﾇ	ﾗ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ｨ	ｸ	ﾈ	ﾘ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ｩ	ｹ	ﾉ	ﾙ	ι	≦
1	0	1	0	A	LF	♤	*	:	J	Z	j	z	LF	Υ	ｪ	ｺ	ﾊ	ﾚ	κ	≧
1	0	1	1	B		⊼	+	;	K	Ä	k	ä		Φ	ｫ	ｻ	ﾋ	ﾛ	λ	±
1	1	0	0	C		Σ	,	<	L	Ö	l	ö		Ψ	ｬ	ｼ	ﾌ	ﾜ	μ	℃
1	1	0	1	D	CR	⌑	-	=	M	Å	m	å	CR	Ω	ｭ	ｽ	ﾍ	ﾝ	ν	Ꞇ
1	1	1	0	E	SO	✱	.	>	N	^	n	–	SO	SP	ｮ	ｾ	ﾎ	ﾞ	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	_	o		SI	SP	ｯ	ｿ	ﾏ	ﾟ	ο	

Note: . SP is space code.

. Don't use undefined codes.

Code chart 9 FONT $ 8, (Denmark)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	'	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	◫	£	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Ⓗ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		◷	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ħ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		╳	'	7	G	W	g	w		Θ	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	⩚	•		J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		⧖	+	.	K	Æ	k	æ		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		⧗	,	<	L	Ø	l	ø		Ψ	ャ	シ	フ	ワ	μ	∈
1	1	0	1	D	CR	⌑	–	=	M	Å	m	å	CR	Ω	ュ	ス	ヘ	ン	ν	⊂
1	1	1	0	E	SO	✳	.	>	N		n		SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	–	o		SI	SP	ッ	ソ	マ	゜	ο	

Note:
- SP is space code.
- Don't use undefined codes.

Code chart 10 FONT $ 9, (Spain)

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	'	p		SP	SP	ー	タ	ミ	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q		Γ	。	ア	チ	ム	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r		Δ	「	イ	ツ	メ	β	σ
0	0	1	1	3	ETX	◫	₧	3	C	S	c	s	ETX	Z	」	ウ	テ	モ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t		Ⓗ	、	エ	ト	ヤ	δ	υ
0	1	0	1	5		◷	%	5	E	U	e	u		Λ	・	オ	ナ	ユ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v		Ħ	ヲ	カ	ニ	ヨ	ζ	χ
0	1	1	1	7		╳	'	7	G	W	g	w		Θ	ァ	キ	ヌ	ラ	η	ψ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS	Π	ィ	ク	ネ	リ	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y		Σ	ゥ	ケ	ノ	ル	ι	≦
1	0	1	0	A	LF	⩚	•		J	Z	j	z	LF	Υ	ェ	コ	ハ	レ	κ	≧
1	0	1	1	B		⧖	•	.	K	¡	k	|		Φ	ォ	サ	ヒ	ロ	λ	±
1	1	0	0	C		⧗	.	~	L	Ñ	l	ñ		Ψ	ャ	シ	フ	ワ	μ	∈
1	1	0	1	D	CR	⌑	-	-	M	¿	m	)	CR	Ω	ュ	ス	ヘ	ン	ν	⊂
1	1	1	0	E	SO	✳	.	>	N		n		SO	SP	ョ	セ	ホ	゛	ξ	∞
1	1	1	1	F	SI	✡	/	?	O	–	o		SI	SP	ッ	ソ	マ	゜	ο	

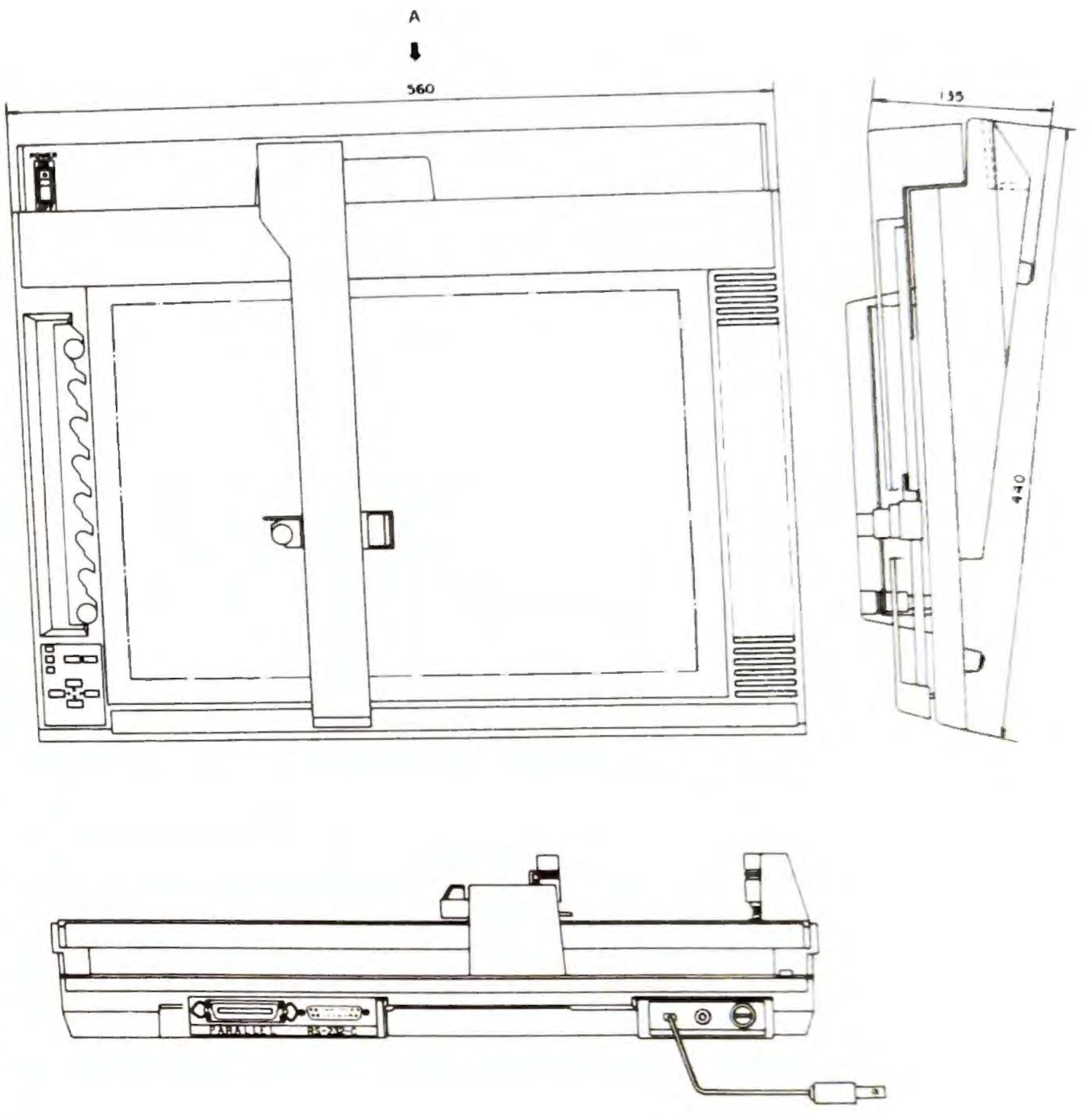
Note:
- SP is space code.
- Don't use undefined codes.

Code chart 11 FONT $ 10

					B_8 = 0 (When using 8-bit code)								B_8 = 1 (When using 8-bit code)							
					S I								S O							
				B_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		0	1	2	3	4	5	6	7	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
0	0	0	0	0		SP	SP	0	@	P	'	p					SP	Π	SP	π
0	0	0	1	1		•	!	1	A	Q	a	q					Α	Ρ	α	ρ
0	0	1	0	2		◇	"	2	B	R	b	r					Β	Σ	β	σ
0	0	1	1	3	ETX	⎕	#	3	C	S	c	s	ETX				Γ	Τ	γ	τ
0	1	0	0	4		△	$	4	D	T	d	t					Δ	Υ	δ	υ
0	1	0	1	5		◷	%	5	E	U	e	u					Ε	Φ	ε	φ
0	1	1	0	6		⧗	&	6	F	V	f	v					Ζ	Χ	ζ	χ
0	1	1	1	7		✕	'	7	G	W	g	w					Η	Ψ	η	ϕ
1	0	0	0	8	BS	+	(	8	H	X	h	x	BS				Θ	Ω	θ	ω
1	0	0	1	9		Y	)	9	I	Y	i	y					Ι		ι	≦
1	0	1	0	A	LF	⍏	•	:	J	Z	j	z	LF				Κ		κ	≧
1	0	1	1	B		⧗	+	;	K	[	k	{					Λ		λ	±
1	1	0	0	C		⧖	,	<	L	\	l	¦					Μ		μ	¢
1	1	0	1	D	CR	⌑	-	=	M	]	m	}	CR				Ν		ν	Ⅽ
1	1	1	0	E	SO	✳	.	>	N	↑	n	~	SO				Ξ		ξ	∞
1	1	1	1	F	SI	✡	/	?	O	←	o		SI				Ο		ο	

Note:
- SP is space code.
- Don't use undefined codes.

12. EXTERNAL VIEWS



The specifications, etc. in this manual are subject to change without notice. For further details, please feel free to contact us.

August 10, 1987
GRAPHTEC CORPORATION Plotter division

WESTERN GRAPHTEC

WESTERN GRAPHTEC, INC.

11 Vanderbilt
Irvine, California 92718-2067
In California 714-770-6010 or 800-624-8396
Outside California 800-854-8385

Printed in Japan

WESTERN GRAPHTEC

WESTERN GRAPHTEC, INC.

11 Vanderbilt
Irvine, California 92718-2067
In California 714-770-6010 or 800-624-8396
Outside California 800-854-8385

Printed in Japan